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VOL. 21 MAY, 1929 No. 5

WATERSHED PROTECTION PRACTICE IN CALIFORNIA[1]

MARIN COUNTY

BY JOHN BURT[2]

As an opening statement for the symposium on the subject of Watershed Protection let us say that old Mother Nature has for the most part given us watersheds that are clean; hills and mountains uncontaminated; covered with vegetation, grass, shrubs, bushes and trees. This growth is of considerable value, tending to decrease evaporation and preventing, to an extent, the washing away of the soil.

If Nature could be left undisturbed there would be no necessity for this symposium, but we all know that the human element has to be taken into consideration. As time goes on, and population increases, it becomes more necessary to see that the laws governing sanitation of a watershed area are observed in every respect.

The watershed from which our Marin Municipal Water District supply is obtained covers an area of 10,450 acres. We have now under condemnation proceedings the land adjacent to this area consisting of 5050 acres, making a total of 15,500 acres. This land is situated on the slopes of Mount Tamalpais. The mountain stands out prominently in the Coast Range of hills to the north of the Golden Gate, overlooking the entrance to San Francisco harbor. It seems

[1] Presented before the California Section meeting, October 7, 1927.
[2] General Manager, Marin Water District, San Rafael, Calif.

to be a natural rain maker, as the records show the average rainfall for the last forty-seven years has been 55.73 inches. The steep character of the slopes has produced an average runoff from 1912 to 1927 of 61 per cent.

To protect this area as a watershed for a domestic water supply is an exceptionally difficult task, as the mountain is used as a playground by thousands of hikers and automobile parties that come from San Francisco, Oakland, and all surrounding cities and towns. There is a hotel at the summit, a railroad from Mill Valley to the top, a boulevard traversing its entire backbone and a county road that follows the shore line of one of the lakes for several miles. These public highways and the many trails leading to the top from all sides of the mountain bring many people to our county every weekend, and it requires constant vigilance to keep this area free from contamination and to protect it from fires during the dry summer months.

This land is owned by the Water District, and is for the most part covered with a heavy growth of brush, huckleberry, manzanita and wild lilac, and with trees such as redwood, madrone, laurel and oak. It is all in the state game refuge. Deer are abundant and our three lakes are stocked with trout of several varieties by the state.

We have three patrolmen and one look-out man regularly employed. In addition to these we have the assistance of the fire wardens that are in the employ of the Tamalpais Forest Fire District. The game wardens also help us in many ways and at many times, as do many of the hikers who belong to hiking clubs interested in keeping the mountain for a public playground and a beauty spot where they may come for recreation and nature study.

There are no human habitations on our watershed lands, except those necessary for the patrolmen, and the strictest sanitary regulations are observed in connection with them. The drainage from the land on which the hotel at the summit is located does not come into our watershed area, but is carried off through a ravine that we do not use to the Pacific Ocean.

On the very top of the east peak of the mountain is located a look-out station that is occupied by a man who is thoroughly familiar with the country around the mountain, and can exactly describe the location of any fire that may be within the boundaries of the Water District. From his station he can overlook the whole watershed area, and as the station is equipped with a telephone, he is our most valuable man at the time when a fire breaks out. By his watchful-

ness and quick action in reporting a fire, we are frequently able to reach the scene in time to stop the flames before they do much damage.

The pasture land on our watershed, which is only a very small part of the whole area, is leased for grazing purposes and thereby affords additional protection from fire by keeping the grass short and also by giving us the service of another man, if needed, in the person of the herder.

We hope to keep Mount Tamalpais watershed open to the public as a park, and have gone to the expense of providing fire-places, picnic tables, convenience stations and water taps at certain favorable spots on the mountain side that are best suited to such uses. We ask only that the parties who take advantage of the facilities we offer them for a pleasant outing, shall keep the grounds clean, and respect our rights by doing nothing that will contaminate or pollute our water or our watershed lands.

In conclusion, let me say that we know that we are having success with our methods, at least up to this present time, because we take samples of the water, both before and after chlorination, and these samples are tested very carefully in our own laboratory to be sure that the water is safe for domestic use. Samples are also sent to the State Board of Health at certain intervals for verification. We have always found that even the raw water, before being chlorinated, was quite safe for drinking purposes.

East Bay Water Company

By George W. Hawley[3]

The East Bay Water Company has a developed domestic and industrial water supply of 42,000,000 gallons daily to meet the requirements of the municipalities and unincorporated territory lying on the easterly side of San Francisco Bay. Approximately 30,000,000 gallons daily of this total supply are obtained from a catchment area of about 80 square miles lying in the westerly part of Contra Costa and Alameda Counties. The lands lying within the catchment area may be classified generally as wooded hill areas, grazing lands, and agricultural lands and are sparsely settled

Storage reservoirs totaling 33,000,000,000 gallons capacity provide for a long period of detention of runoff from these catchment areas.

[3] Assistant Chief Engineer, East Bay Water Company, Oakland, Calif.

All water supplied from these sources is filtered in rapid sand filtration plants and the waters are further subjected to chlorine disinfection.

The Water Company early in its history adopted a policy of acquiring the major portions of the watershed lands, thereby securing control and jurisdiction over sanitary conditions, fire hazards and supervision of property rights. Jurisdiction over the sanitary and fire hazards of lands not owned by the company is made available through state authority and through coöperation with the owners.

SANITATION

The Water Company, cognizant of the ever-increasing public demand for a safe water with a high degree of purity and appreciative of the aestheticism and sentimentality of the public, maintains a strict and rigid sanitary supervision over all watershed lands. A definite inspection and patrol policy, conforming with approved sanitary requirements and with the rules and regulations established by law, has been adopted. This control is exercised upon the tenants who lease company lands, private land owners and persons entering upon or traversing the watershed lands. These rules and regulations in part require

1. The installation and maintenance of sewage disposal facilities of an approved type located not less than 200 feet from any body of stored water or water course. The effluent from these disposal plants must at all times be maintained beneath the ground surface or sterilized and covered.
2. Garbage and household refuse must be burned or buried and covered to a depth of not less than 2 feet and at a distance not less than 100 feet from any stream or waterway.
3. Carcasses of dead animals must be burned or buried and covered with a soil depth of 2 feet and at a distance greater than 500 feet from any stored water or waterway.
4. No poisoned bait, animal or vegetable matter except poisoned grain for the extermination of rodents is used on the land of the company and then only under the supervision of the person in charge of lands.
5. Hunting, fishing, boating and swimming is prohibited on the properties and streams under the control of the company.
6. The right to enter upon or traverse the watershed lands under the control of the company requires a permit which is granted for educational or scientific purposes only.
7. All animal industries upon the lands are regulated as to location and their activities must conform to the legal requirements for the protection of lands used for the production of public water supplies.

8. Sanitary supervision is maintained over utilities and other construction organizations working upon or through the watershed lands.

Three major safeguards are employed to protect the water supply: first, protection of supply against contamination at its source; second, long period detention in storage reservoirs; third, filtration and disinfection with chlorine.

The effectiveness of sanitary patrol is well illustrated by the fact that the B. coli content of the raw water is well within the Treasury Department's standards of purity.

FIRE PROTECTION

The benefits and advantages that result from the elimination of fire hazards and decrease in fire losses upon watershed lands are manifold and warrant the adoption and maintenance of an adequate fire prevention policy and organization. The denudation of horticultural growth and control of soil erosion have a marked effect upon runoff, evaporation and reservoir silting. With such a policy, personal and property losses are maintained at a minimum.

An ever present and real source of great fire danger and hazard to the East Bay municipalities has been eliminated by the organization of satisfactory and well organized protective measures in the adjoining back country.

Interested individuals, companies and municipalities, realizing the fire hazard that would result from an unprotected watershed area, organized the Contra Costa Hills Fire Protection Committee. The purpose of this committee is the supervision of fire prevention and fire fighting activities necessary to protect the lives and property within the district. This committee functions under the supervision and with the approval and authority of the Federal, State and University of California divisions of forestry.

A District Forest Ranger is in direct charge for the committee and supervises and enforces the state laws which have to do with fire hazards and fire fighting. Permits for burning are issued by the ranger only after inspection and upon the conditions imposed. If necessary instructions are given for safe burning.

Two siren equipped fire towers are located at the points of highest elevation on the watershed areas and a man is continually on duty in these towers throughout the fire season. Complete fire fighting equipment and tools are maintained at readily accessible points of

vantage throughout the fire area. This organization functioning as it does under state authority is authorized to draft the needed personnel to combat any fire within the area.

PROPERTY PROTECTION

As a corollary to sanitary and fire protection activities, control over hunters, fishermen, picnickers, hikers, campers, etc., tends towards the elimination of trespassing and to the consequent protection of the lives and property of the landowners.

ORGANIZATION

The Water Company maintains a separate and complete organization for the enforcement of its watershed protective policies.

The watershed area is divided into seven districts on a basis of work to be performed rather than the area. A patrolman is assigned to each district and lives within the district with complete charge of all sanitary and fire patrol work. Living accommodations and transportation facilities are provided for each district man. Each patrolman is deputized by the sheriff of the county in which his district lies.

Throughout the entire history and program of watershed protection under the jurisdiction of the company especial effort and stress have been directed to the improvement of sanitary and fire hazard conditions by educational and coöperative endeavor. The patrolmen have been trained and instructed to coöperate and work with the watershed population to the end that sanitation and fire protection may be improved. A friendly spirit of willing coöperation has obtained in practically all instances and the accomplishments speak well for the effort put forth.

The entire sanitary and fire patrol is under the supervision of Paul I. Daniels and William H. Jordan who is a district forest ranger from Alameda and Contra Costa Counties and in direct charge of the fire control work.

San Diego County

By R. C. Wueste[4]

I feel that the best way to approach the question of sanitary watershed protection in San Diego County is to describe the situation as it

[4] Supervisor, San Diego Water Impounding Bureau, San Diego, Calif.

exists, call attention to the results as we find them and finally draw certain tentative conclusions which may be modified later when the light of further local investigations has been thrown on this question.

DESCRIPTION OF WATERSHEDS

Surface water development in San Diego county depends upon the use of an area 30 to 40 miles wide lying parallel to the coast line and about 10 miles therefrom. The geology of this area is largely granitic; the mean soil cover susceptible to percolation is shallow; the topography is very rugged, lying between elevations of 300 to 6000 feet above sea level. The rainy period, producing run-off, begins early in December and ends in May. Only occasional erratic storms produce run-off of short duration at other times of the year. Normally then, San Diego County watersheds produce no surface flow during six months of the year and are open to the sterilizing effects of exposure to sunlight, warmth, low humidity and oxidation.

The watershed areas are semi-arid, mostly non-agricultural, sparsely settled and adapted only to limited grazing operations. Human occupancy averaged less than one inhabitant per square mile in 1915 and has not materially increased since. About 17 head of cattle per square mile was the extent of grazing operations in 1915. The greater portions of the watershed areas are still unpatented public domain and will probably remain so always.

CHARACTER OF RUN-OFF

As might be expected, run-off from rainfall on such an area may be gentle with very little suspended matter burden, or violent to the degree of carrying great quantities of eroded organic and inorganic materials. When storm run-off of 400 to 500 cubic feet per second per square miles occurs, extraneous substances reach the reservoirs from all portions of the watersheds. The floods of January, 1916, carried into the reservoirs timber and detritus indicating the stripping of many slopes to bedrock.

SELF-PURIFICATION OF STORED WATER

Run-off must be brought to rest in the artificial reservoirs to be withdrawn as dependable, safe net yield. The mathematics of this conversion show that a given run-off volume may remain in storage in decreasing amount over a ten- or eleven-year period without material

accretion. Whatever then the quality of reservoired water may be shortly after a harvest, its quality will be subject, over long periods, to such modifications per se as are provided by storage with natural and certain artificially applied factors operative. Most San Diego County reservoirs expose more than 1000 acres when full with average depths from 35 to 100 feet. Wind and wave action, convection, lateral circulation, oxidation in surface strata, reduction in deep strata, sedimentation, subsidence, and the biochemical cycle, are constantly at work.

The run-off volume resulting from a given peak season may be expected shortly after impoundment to be heavily burdened with clays, silts, salts earth-bacteria, bacterial food, algal seeding organic and inorganic flotsam, plankton and pollution of all kinds. Still the degree of dilution is so high that the sterilizing agencies can quickly and successfully do their work.

American sewerage practice is replete with applicabilities illustrating sterilization through dilution. New Orleans, at the mouth of a river on which nine million people live, but with no major pollution 600 miles upstream, obtains comparatively acceptable raw water from the Mississippi.

On the other hand, John R. Freeman, in his report on the Hetch Hetchy water supply, plainly strikes at the time-old reliance on the more active self-purification of running water over ponded water. Mr. Allen Hazen's views on the subject in the same report support the iconoclastic opinion that self-purification of reservoired water is far more reliable than self-purification in flowing river water.

WATERSHED PROTECTION IN SAN DIEGO COUNTY

The United States Forest Service has made effort, since the creation of the Cleveland National Forest in 1907, to conserve the brush cover and meager timber stand on San Diego County watersheds. Only small attempt at reforestation and afforestation has been made. All these activities as they concern watershed areas were intended to reduce erosion, stabilize stream flow and retard silting of reservoirs. Under run-off conditions as indicated above, the success of efforts of this kind as applied locally is dubious. The success of wholesale afforestation under local climatic conditions does not appear very hopeful.

The State Board of Health, the San Diego County and City Health Departments and the Water Impounding Bureau are exercising more

or less complete control over pollution influences on the watersheds, such as sewage disposal, animal and waste pollution and accidental human pollution, especially near or on territory surrounding the reservoirs. Sub-surface disposal of sewage is insisted upon, cattle and other domestic animals are prevented from having access to reservoirs and the lower reaches of effluent streams.

More complete sanitary control is carried into effect on the reservoir basins in which the watersheds terminate and where the run-off is held in retention. It is considered necessary to fence these, provide patrol against violation of common sense decencies, keep the water under algal control and submit same to simple purification processes upon withdrawal: namely, rapid pressure filtration, disinfection by chlorine and aeration.

Public access, however, has been permitted to these reservoirs since their creation under increasing restrictions.

RECREATIONAL USE OF RESERVOIRS

No other phase of San Diego County's principles unto herself regarding water sanitation, has come more under discussion than that one of permitting recreational use of her domestic water storage reservoirs. Every major reservoir in the County is used for this purpose. The volume of public use is increasing year by year. Public use is becoming an important side-line judged from number of patrons served and money taken in. The fact that other parts of Southern California do not afford similar fishing and hunting opportunities produces a concentration here which is making this county far-famed as a playground. The activity has been systematized and is scheduled for further development, all providing that the practice can be proven harmless to the water supply. Not enough direct data can be submitted at this time to prove the case either way. Indirect data would seem to indicate that under adequate control, the natural and artificial purification processes have kept San Diego water potable and pathogenically safe. Again, Mr. John R. Freeman, in his Hetch Hetchy Supply Report, devotes considerable space to prove that such a dual use of a supply is not necessarily incongruous or incompatible.

QUALITY OF SAN DIEGO WATER

San Diego surface water has a mineral content similar to most Southern California waters.

The physical quality of stored water at the tap has with few exceptions been notably acceptable and palatable.

The safety of San Diego City water has been so unquestioned that analytical tests thereon have been rather incompletely carried out. Inaugurated by this bureau, water sampling and analysis are fast being given the attention it deserves for complete control and study of influences.

San Diego water is accepted by the Army, Navy and Marine Corps, by interstate carriers and the Bureau of Animal Industry. In ten years no local case of typhoid fever has been traceable to the water supply.

CONCLUSIONS

The following conclusions are those of the writer and have been arrived at by application of the broadest perspective and weighing of the conflicting arguments on the question, which he has been able to bring to bear. The conclusions are supported in part or in whole by many technical men acquainted with the conditions in San Diego County. On the other hand, diametrically opposite views are taken by some. Necessarily, the writer's attitude is such that, if future investigations or modifications in conditions disclose the advisability of modifying the following conclusions, no one will be more ready to change his viewpoint and recommend operation of the impounding system in accordance therewith.

1. General. Sanitary science is not an exact science and the principles thereof are subject to modification in the light of special conditions and the submittal of new data.

2. Peculiar San Diego conditions. It may be that climatic, topographic, geologic, hydrographic, agricultural and other conditions in San Diego County make possible or advisable certain modifications from standard practice of watershed protection considered inviolable elsewhere.

3. Brush cover, afforestation. Conservation of brush and timber cover on local watersheds has been indefinitely successful and it is questionable whether erosion over long periods of time can be hoped for to materially reduce the loosening, transportation to and final deposit of detritus in our reservoirs. The watershed areas seem not to lend themselves to extensive afforestation.

4. Ownership. Already highly expensive, from the necessity of the construction of large impounding works, local development programs

will probably never contemplate the exclusive ownership of watersheds. Nor is the necessity for this policy believed to exist under local conditions.

5. Partial ownership. Effort in all cases has been made to secure, in ownership and control, a strip of land sufficiently wide surrounding a storage reservoir to allow for future additions to the dam, the location of peripheral patrol roads, the exclusion of residences within a reasonable distance from high-water shorelines and the detection of fluid pollution escaping from residences beyond this strip.

6. Grazing. Grazing operations in San Diego County were probably at their peak in the early part of the nineteenth century. It is not believed that the extent of the locally supported cattle industry will ever materially increase. As a health menace, cattle pollution is of course not to be compared with human pollution.

7. Mineral quality. It is believed to be a far-fetched hope that mineral quality of San Diego County developed surface water may ever be modified by watershed control.

8. Algal control. Algal control of reservoired water might be expected to be necessary in any body of water anywhere regardless of watershed control. Color, taste and odor quality depend on algal control.

9. Bacterial quality of raw water. Bacterial quality of San Diego County stored water has not been sufficiently studied in the past to warrant special or general conclusions. Future studies should be depended upon for the outline of control measures necessary for insurance of this phase of stored water quality.

10. Public access. The local practice of allowing recreational use, which has drawn fire from many competent sanitarians, should in all fairness be condemned only upon the results of studies and investigations rather than on the insistence by one school of sanitarians that the practice be arbitrarily discontinued. Such studies should be comprehensive and over a sufficiently long time period to warrant conclusions.

11. Purity of supply. The fact that the purity of San Diego's water supply has been a byword for the last fifteen years under conditions as have been outlined in this paper, should certainly enter into the evidence concerning the wisdom and acceptability of local water works' practice. The record which has been established on the quality of San Diego water, together with the open question of allowing public access to San Diego County reservoirs are bound to

instill a psychological incentive among local water works officials to zealously safeguard that reputation.

12. Watershed protection. In view of everything that has been said before, it is believed that any undue increase in protective measures applied to San Diego County watersheds, exclusive of the reservoir enclosures, would at this time appear unwarranted and unjustifiable and would constitute an error in economic judgment.

Los Angeles

By Carl Wilson[5]

Just what measures shall be adopted for the protection of watersheds seems to me to depend upon circumstances, for each reservoir is a problem which in some respects must differ from all others. Consider the case of our Haiwee Reservoir. It has a catchment area above the point of diversion from Owens River of 3300 square miles, upon which the population is less than two per square mile. Sixty-five miles of open conduit brings the water from the intake across the desert to the reservoir, which is in a barren unpopulated wilderness where the annual rainfall is less than 3 inches. It is perched upon a divide, with a dam at each end. The lake is $7\frac{1}{2}$ miles long, divided into three distinct basins which preclude the possibility of water short-circuiting from inlet to outlet. Storage here is never less than three months, while additional time is afforded in lower reservoirs before water reaches the consumer. Natural purification processes have every opportunity here for completion of their work. What protection of this watershed is required to safeguard the citizens of Los Angeles, 200 miles away? None, other than to prevent the sewage of Bishop, Big Pine, Independence and Lone Pine from directly entering the river or the conduit above the reservoir. To spend money on such a watershed would be an unjustifiable waste.

In contrast to this is our Lake Hollywood, lying on the edge of the City and wholly within the metropolitan district. The catchment area is slightly less than 1 square mile, located in Weid Canyon, on the flank of Cahuenga Peak. The desirability of the surrounding sharply sloping hillsides for residential purposes has been greatly enhanced by the creation of a beautiful lake and already many palatial homes have been built overlooking the water. Within a

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short time all the basin outside the City's property will be dotted with houses, with a resident population larger than that of many California towns. Water from this reservoir goes into service fifteen minutes after it enters the outlet tower. What protection is required here? Surely the maximum degree.

Between these extremes we have reservoirs whose surroundings differ greatly from those I have described, with no two quite alike.

It is natural, then, for us to divide our reservoirs into two classes, storage and distribution, and to treat them differently in the matter of sanitary regulations. Our policies in regard to both classes are definite, but they cannot be considered final in details, for as the region develops we have to modify our ideas.

Our storage reservoirs are all situated where there are no communities upon the tributary watershed, so we have no sewage problems to solve. We must prevent pollution by domestic animals and by campers and ranchers. Water from storage reservoirs generally passes through a distribution reservoir before entering service, and usually receives some measure of purification just before being sent to the consumer. This being the case we require the effluent from storage reservoirs to be good enough to place no undue burden upon the purification process, but more than that is not necessary. To achieve this end the protective measures are few, and we have not felt it necessary to own large areas surrounding our lakes. The California health laws are very comprehensive and clear. They wisely place the burden of preventing pollution of domestic waters upon the individual, not upon the water purveyor, and we find it quite as easy under the protection of these laws to prevent nuisances upon privately owned land as upon ground belonging to our Department. We feel under such circumstances we are not justified in sinking immense sums of money in needless ownerhip of land. Here in Southern California property values have risen so rapidly and to such high figures, that a municipality can afford to own only barely as much land as is required to satisfy the purpose in hand. Perhaps a private water company may properly hold large areas for the combined purpose of protecting its reservoirs and as an investment upon which it is hoped to profit in the future. Municipalities are not looking for profits of this type, and would surely be criticized for purchasing large tracts of property for the sake of accomplishing an object which might be more cheaply obtained in some other manner. If we hold real estate we must pay taxes upon it, and it may

be urged that we should put such property to some useful purpose instead of permitting it to remain fallow. As Hamlet might say, "To lease, or not to lease; Aye, there lies the rub," for in that effort at use, what dreams may come of leases to irresponsible people who abuse the privilege with resultant pollution of our water. Eastern practice has shown us that perfectly safe water may be drawn from heavily populated watersheds, and in the future it will be necessary for us to operate under similar conditions. I believe we should begin now to handle our works so that a heavy population near our reservoirs cannot jeopardize the safety of our supply.

Our policy demands fencing of all storage reservoirs, and this detail is an accomplished fact. Each reservoir is patrolled by a resident keeper, while sanitary inspections are frequently made by inspectors from the Sanitation Division. Hunting, fishing, boating, bathing and picnicking are prohibited on all reservoirs operated by the Department, and this restriction is rigidly enforced. Over one hundred and fifty convictions for violation of this rule were obtained during the spring and summer of 1927.

Grazing is prohibited within one-half mile of storage reservoirs, but where circumstances show sufficient menace this distance is increased. No difficulties in enforcing this regulation have yet been encountered beyond that of convincing stock owners that we mean business. Once they realize we are in earnest they cease to annoy.

Leaching type cesspools are not permitted within 250 feet of storage reservoirs, or of waterways leading thereto. This regulation must, however, be flexible, for under some circumstances it may be prudent to extend the distance to 500 or 1000 feet, or in some soils to entirely prohibit such disposal. Properly constructed earth vaults are approved at distances greater than 250 feet.

Reforestation has not yet been undertaken by the city of Los Angeles, although hundreds of trees have been planted around our reservoirs for ornamental purposes. The principle of tree planting on a large scale over catchment areas is approved by the Department as a water conserving measure, but we own no areas where such planting could advantageously be done.

Our policy regarding distribution reservoirs calls for fencing with strong wire mesh supported on steel posts set in concrete, and so designed as to make it very difficult, if not impossible, for anyone to climb over them. Several of the most important reservoirs have already been so treated, and others are now being fenced. Gates are

kept locked, and the public is denied all use of the reservoir property except passage over the roadways. Resident keepers are maintained at all distribution reservoirs, and inspectors from the Sanitation Division make more frequent rounds than at storage reservoirs. An elaborate by-pass system for storm water has been constructed around several of these reservoirs, and plans are made for protecting the others in a similar manner in the near future. At Lake Hollywood, and Silver Lake a substantial reinforced concrete wall ranging from two to several feet high, has been built as a curb along the water side of an encircling highway, thus converting the paved street into a storm drain.

Sanitary sewers are required for residences within the drainage area, to carry sewage outside the reservoir basin. Where collecting or intercepting sewers pass near the water and are thought to constitute a menace, they are constructed of cast iron pipe with lead joints, laid under approval of engineers and inspectors from the Water Department. In order to obtain the necessary checks upon sewers we have a coöperative arrangement with the City Engineer which works very satisfactorily. Before plans for a new subdivision or for sewer extensions can be recorded they are sent to the Water Department and must bear our approval, attested by signature of our engineer on the tracings. This enables the Water Department to prevent unsafe installations instead of having to find them after trouble had developed. Leaching cesspools and earth vaults are not permitted on distribution reservoir sheds. Domestic animals, including chickens, are not allowed within 100 feet of the water.

All water leaving distribution reservoirs to enter service should be chlorinated. The equipment should be in duplicate and generally should be automatic in operation. Great care must be taken to obtain continuous and efficient chlorination, and the relatively small cost necessary to secure it should be regarded one of the wisest uses of money. Where the raw water is never heavily polluted, as is the case in Los Angeles, and the reservoirs and conduits are carefully safeguarded, no other purification seems necessary to insure a safe water at all times.

The Spring Valley Water Company

By George J. Davis[6]

My area is confined to the Peninsula System of the Company. We have some 37 square miles of watershed, and we have been fortunate in being able to acquire practically the whole of the watershed area. The small portion which does not belong to us is directly under our control.

Through the watersheds we have a number of county roads, also the Skyline Boulevard, and it is to those areas that we look for trouble.

Mr. Burt mentioned the picnickers over in Marin County are very good in taking care of the watershed. I should say that 90 per cent of the picnickers are careful. There might be a few more, but I do not know that I can say very much for the remaining 10 per cent. We find our roads strewn with picnic lunch boxes and papers, actually littered with newspapers. It is very wonderful what can be done with a Sunday newspaper. We find plenty of work for a number of men to gather these papers once a week with the assistance of the regular watchmen and an automobile.

We have put out garbage cans where the picnickers may be most likely to locate. We have found they are excellent targets for the young huntsman. However, some of the people will discard their garbage into the garbage can.

To prevent the people from getting near the water, we have had to do considerable fencing, and the type of fencing we construct does not encourage the public to go through or over it. It consists of a barbed-wire fence, about 5 feet 6 inches in height, seven strands of barbed-wire, some metal posts, some sawed redwood posts, and the other regular farm fencing. The metal posts are used in the areas which we consider practically free from fog.

We have some 17 miles of this fencing, which we constructed ourselves, at a cost of 15.8 cents per foot on the county roads with few turns; and where there were numerous turns with some brush we constructed it at a cost of 20 cents. This does not include overhead cost. It is actually the cost of construction.

We have about 34 miles of this barbed-wire fence with sawed redwood posts. That is a little more expensive to construct. I

[6] Superintendent of the Peninsula System, The Spring Valley Water Company, San Francisco, Calif.

find our unit of cost on that is 22.8 cents per foot. This type of fence, in addition to the metal posts, is along the county roads. Where we are not bordering on the county roads and using line fencing, we use a regular farm type of fencing, split redwood with about three strands of barbed-wire.

We post the roads with regular warning signs, advising the people that this is watershed territory, and also that we do not allow hunting and fishing, etc. We post these notices every 500 feet, to conform to the State law, so that should we have trouble with the trespassers we can go to the courts and take care of ourselves properly.

We have done a little forestry over the watershed, especially on the Eastern slopes, at Crystal Springs, San Andreas, and Pilarcitos Lakes. The last few years we have been experimenting with the gathering of acorns from the tanbark oak on our own property, with Douglas-fir cones and the redwood. We thought we were pretty good foresters. We went out and spaded up small areas, 2½ feet square, and brought in about 2 or 3 inches of redwood mold, which we scattered over the top of the spaded areas. We then planted four oaks, Douglas-firs or redwoods; and to show you how good we were as foresters in reality, the first seeds that came up were big-leaf maple.

To conform to our county ordinances we destroy the thistles, the regular bull thistles, cutting them down with scythes or a mattox; and yet we are unable to stop their spread. The seeds come over to us from adjoining owners who are probably not taking the precautions we ourselves are.

We have also to destroy the ground squirrels, by poisoning, during the summer months with poisoned barley; and during the damp weather with carbon bi-sulphide. We are practically free from squirrels.

Each spring we grade fire-trails over all the ranges. These trails are graded with the regular road-grade. In some places we have to use teams, and in other places we have gotten by with a Fordson tractor; but some of the slopes being too steep we have stuck to the old teams. These trails are wide enough for automobiles to travel. You, of course, appreciate the necessity of putting out a fire as soon as possible, to prevent it travelling over the area.

In addition to the graded area we cut back about six feet of brush on either side of the road.

Of course, these trails can also be used for backfiring. We have

found them on occasions very useful when we have had recourse to backfiring.

As to sewage disposal, I have stated that we own practically the whole area, so the only habitations we have are those of the watchmen and caretakers of the watershed.

I mentioned just now that we had about 37 square miles of territory; and I think we average about one person per square mile of territory.

At each of these watchmen's cottages we have a concrete sump, and once or twice a year it is necessary that we pump these cesspools out and haul the sewage off the watershed. We pump it by means of a small diaphragm pump, into a tank mounted on one of the trucks and dispose of it in that way.

Just before the winter season it is necessary—that is, after the law permits us to start fires,—that we burn off brush and weeds and grass below the high-water mark of the reservoirs, trying to limit the rotting and decay of vegetable matter so the water will not become polluted.

In addition to this we send our men around just before the rainy season begins to make a very close inspection of all ravines bordering along the highways, to look out for possible trouble which might occur when the floods commence; and we have been very successful in taking care of our watershed area in this way.

The State Board of Health Viewpoint

By Ray F. Goudey[7]

We have had a great many divergent viewpoints; yet if we had time to discuss them we would find there was a good meeting place.

A great many water works men come from other states, or water works operators, I might say. Some of them think that California is a Utopia, that we do not have to do anything with our waters. I met one gentleman who had just come from Oregon to take care of a water supply; and he had a lot of trouble with his chlorinator, and we made things worse. He said, "Where I come from they do not have any trouble with the water at all," and then he corrected himself, "except to keep it out of the milk."

The state has only general laws on watershed protection. There are no specific regulations, like Mr. Hawley read, because we take the viewpoint that Dr. Wilson does, that each case is a problem by

[7] Resident Engineer, State Department of Health, Los Angeles, Calif.

itself. We must understand the local conditions, and adopt, and make suggestions, pointing out weaknesses and making recommendations which will give, if possible, the maximum use of the reservoir for recreation, consistent with that which will give a safe water to consumers at all times.

We do our best to elevate the standards, but when it comes to a finality we must revert to minimum requirements, which is sometimes less than you water works men would stand for.

Watershed use for recreation purposes is undergoing an evaluation, and we take the standpoint it is all experimental; that we or the water companies should enter upon it with great caution.

Peculiarly, those cities which have let down the bars the most are those which do not have proper treatment. We, therefore, take the stand that any city or water department that wants to let down the bars should first put its water above reproach, and have proper and adequate treatment. Chlorination is not sufficient in most cases. In the winter time we must remove mud. In the summer time odorous features and even fish tastes of the water must be met. Complete treatment, therefore, means aeration, coagulation, filtration and sometimes chlorination in addition.

Filters even when they are designed at safe rates only remove from 50 to 75 per cent of the impurities, sedimentation removing 80 to 90 per cent. The great advantage really in any treatment plant lies in the successive steps of purification, which most of the water companies have not yet installed.

The total efficiency, using all of these methods is from 92 to 99 plus per cent, and it is only by that method you can produce a water above reproach.

The cost of producing such a water is almost negligible, one to five cents per thousand gallons. Yet it is the duty of every one of us to have proper systems involving the service of water, and we must take it to heart. As Mr. Miller said to us last night, there is a responsibility, and we must live up to it.

Most of these water companies have been guilty in the past with getting-by, I say it advisedly, as cheaply as they can; but I think the times are now changed.

We have in this State four complete treatment plants like the East Bay Water Company's two plants, one at Calexico. The other

fifteen I know of cannot be considered complete; some are simply strainers, some are heavily overloaded, some have no rate control, and the conditions are not favorable to the production of a safe water.

There is a very definite sense of progress. A number of communities, such as Los Angeles, San Francisco, Auburn, and I think a few others, have adopted a method of coagulation. It must be remembered that St. Louis adopted this as a preliminary step over twenty-five years ago; so in that respect we should say we are twenty-five or thirty years behind the times.

It is only a step, an entering wedge, to the time when these cities will have complete treatment. It is then, and then only, that the complaints we now have of a lack of potable water will vanish into thin air.

LEGAL PROBLEMS IN WATER RIGHTS[1]

By Malcolm Lindsey[2]

In the early geographies much of the territory represented by the Rocky Mountain Section of The American Water Works Association was marked the "Great American Desert." Some of the most prominent of the early government explorers, in their official reports, stated that this stretch of country could never sustain any large population because of scarcity of water.

Today there are in this region rich agricultural areas and rapidly growing cities and towns. The reason why the early prophecies have been upset has been due to the fact that the settlers in this region have devised methods to use to advantage what little water there is. This devising of methods has been partly engineering and partly legal. Engineers have contributed new types of conduits; they have planned and built great storage reservoirs; they have studied and devised methods for the economical use of waters. Lawyers have worked out certain legal principles which were not known in the moister states of the Atlantic seaboard or in the Mississippi Valley; they have applied these principles to solve problems which do not exist in the eastern states; and they have produced a body of water law; which, while it has something of kin to the water law of the Spanish American countries, has such distinctive elements that it can be said to be wholly distinct from any other system of water law.

This system of Rocky Mountain water law has been in the making for about seventy-five years now; but a system of law cannot be made in so short a time as seventy-five years. This system, therefore, is still in the making; and there are many problems of water law yet to be solved.

THE DOCTRINE OF APPROPRIATION

The primary doctrine of this new system of water law is that the right to use the waters of a stream shall belong to him who first puts

[1] Presented before the Rocky Mountain Section meeting, February 14, 1929.

[2] Attorney, Board of Water Commissioners, Denver, Colo.

them to a beneficial use to the extent that they are needed for such use. This doctrine, called the doctrine of appropriation, was first announced in California in the days of the use of water for hydraulic mining. When Colorado was settled, some ten years later, the Colorado courts applied the same doctrine to irrigation. Then, still later, California modified the doctrine to a considerable degree. Accordingly Colorado, which preserved the doctrine in all its integrity, has been looked upon as the source of the doctrine; and the doctrine, itself, has come to be known as the Colorado doctrine. This doctrine has been accepted and is now followed by Wyoming, New Mexico, Utah, Arizona, Idaho and Nevada; and, to some extent, by Nebraska.

In considering this doctrine it is important to bear in mind certain definitions which have been worked out and certain principles which have been devised. These definitions and principles must always be borne in mind as the background for any consideration of specific problems. I shall briefly state some of them.

I. What is a stream of water?

A stream of water is said to consist of water in three different situations:

First, the water flowing in the surface channel of the stream;

Second, the water flowing more slowly in the gravels which underlie and are adjacent to the surface stream; and which underground water travels in a course more or less parallel with the water in the surface stream:

Third, underground water on its way toward the stream. This latter water is travelling toward the stream, not with the stream.

II. What are the elements of an appropriation?

The elements of an appropriation are said to be:

First, the intent to appropriate, which intent must be manifested to the world in some tangible manner, as by a notice filed with the proper state official or by the actual beginning of construction work;

Second, the doing of the necessary construction work to utilize the water;

Third, the application of the water to a beneficial use.

If the construction and beneficial use are completed with due diligence the water right relates back to the "first step" taken in the appropriation; and takes effect from the time, although the actual completion may not have been for many years later.

In recent years, a number of the states, following the lead of Wyoming, have provided for a permit system; and in the permits the time for each step is set out.

III. Elements of a complete water right

When an appropriation has been fully completed by construction and beneficial use, the water right has certain distinct characteristics In Colorado there is a legal proceeding in the courts known as a general adjudication suit for the purpose of embodying these characteristics in a court decree, so that there can be no dispute as to what they are. In some of the other states this is also done by court decree. In some of them it is done by a proceeding before the State Engineer or other administrative official or board.

In Colorado the elements of a ditch appropriation which are set out in a decree are:

1. Date, that is the effective date of the appropriation, which determines its right to draw water, as ditches are supplied in the order of their dates;
2. Amount, that is the maximum amount of water per second of time which may be diverted under the appropriation;
3. Headgate, that is the point on the river where the water may be diverted;
4. Purpose, that is, whether for irrigation or some other designated beneficial use or uses.

Certain of the other states require additional statements in the adjudication decree. New Mexcio, for example, requires, in an irrigation decree, a statement of the particular lands to be irrigated.

IV. Changes possible in a water right

From the analysis just made of the contents of an adjudication decree it will be noted that, under the doctrine of appropriation, a water right from a running stream consists of the right to divert at a given point a given quantity of water as of a given date for a given purpose.

Now it often becomes desirable, and in some cases necessary, to change the water right. The principal changes are: (1) change of point of diversion; (2) change of place of use; (3) change of character of use.

Colorado and some of the other states have provided definite legal procedure for the change of the point of diversion. In Colorado the

proceeding is in court and greatly resembles the original adjudication proceeding.

V. Storage rights

So far this paper has been discussing the right to divert water from a stream for immediate use. This is called a direct right to distinguish it from a storage right.

A storage right is the right to impound the waters of a stream in a storage reservoir to hold such waters for later use which may be either (*a*) in a drier season of the same year, or (*b*) in a subsequent, drier year. The principles of appropriation and adjudication hereinbefore discussed apply to the storage rights as well as to direct rights.

VI. How may a city or town acquire water rights?

A city or town may acquire water rights just as an individual or a company may acquire them, as follows: (1) it may sink wells; (2) it may make direct appropriations; (3) it may construct storage reservoirs; (4) it may purchase vested water rights already acquired by others by appropriation.

So far this paper has dealt merely with underlying principles; but the purpose of this paper is to discuss actual legal problems. The underlying principles have only been stated for the purpose of furnishing a background for the consideration of specific problems. These problems will now be taken up.

Problem A. How far can a city or town legally draw water from wells?

The answer is that a city or town may lawfully draw water from wells to any extent so long as no prior water users are injured thereby.

If, however, a well is sunk close to a stream, from which there are existing appropriations, it will often be found that the well is actually getting the stream water, which it could do in one of three ways: (*a*) by withdrawing water from the surface stream; (*b*) by withdrawing water from the underground stream traveling in the gravels; or (*c*) by cutting off percolating waters on their way to the stream.

If a city or town should get stream water by a well in any one of these three ways the courts would enjoin the use of the well at the instance of a prior appropriator from the stream injured by such withdrawal.

Problem B. May a city or town legally build up more storage rights than it annually uses?

This is one of the most important problems now facing our cities and towns in the arid west. If a city or town merely provides for its present needs, its capability of future growth will be impaired. A recent survey of all the larger cities in the United States showed that, on an average, when a city had reached a population of 280,000 it only took twenty years to double that population. During the last few years the movement "away from the farms" has made our cities and towns grow faster than ever before.

The ability to get water for its increasing needs is the first limitation on the possibility of a city or town growing. It must, therefore, supply in advance for its future needs. But it is a principle of the water law of the arid west that one may not appropriate any more water than he needs; and any excess over his needs is subject to appropriation by any one else desiring to use the water.

The reconciliation of these two principles has not yet been made by the courts. There are cases now pending attacking the right of the city of Denver to appropriate more water than it annually consumes. This is just one of the many phases of the water law of the Rocky Mountain region which have not been yet settled. Every city and town is interested in the outcome of this Denver litigation; because if a city or town may not appropriate more water, by storage reservoirs or otherwise, than it annually consumes, it may not adequately provide for its future.

My own belief is that the courts will ultimately announce the following to be sound legal principles:

1. That a city or town may properly hold in storage water for fire protection in excess of its annual consumption; and that merely holding a reasonable amount in storage for that purpose is making a beneficial use of it.

2. That a city or town may properly hold in storage water for extra dry years or a series of extra dry years; and that merely holding a reasonable amount in storage for that purpose is making a beneficial use of it.

3. That a city or town may appropriate a reasonable amount of water to supply its reasonably expected increasing needs over a reasonable period of time.

Problem C. May a city or town lease to others water not needed for immediate annual consumption and then retake the same as needed by the city or town?

The Colorado Supreme Court has indicated that, if a lease so provides, the city or town may retake water which it has leased. This problem is closely associated with Problem B just discussed. If a city or town proceeds to supply itself with a reasonable amount of water for its future needs, there ought to be no reason why the city or town should not lease the water for use in the meantime under leases providing that the water may be taken back for city or town use whenever the needs of the city or town shall require.

The most difficult part of the problem is as to the effect of the return waters. Let us suppose that the persons who lease the water from the city or town use it to irrigate lands. Some of the waters from the lands so irrigated will seep to the nearest stream and there be used again. The city of Denver has had a bill in each of the last two Colorado legislatures to help clarify this subject; but, so far, the bill has not made much progress.

In Idaho there has been a contention by able attorneys that the mere leasing of the water right is an abandonment of it; but I cannot believe that the Supreme Courts of the various arid states will so hold when there has been fully presented to them the imperative need of a city or town to provide for its future water supply. And the leasing of water until needed for annual use is a part of this provision for a future water supply.

Problem D. Why not make no provision for future needs, and, when the need has arisen, condemn whatever water is needed?

This question is asked on every side. It is the constant argument of all people who are opposed to providing for a future water supply to state that a city or town has the legal right of condemning water rights, and can, therefore, afford to sit idly by and wait until the need arises and then condemn all the water necessary.

This argument is plausible. It appeals to the desire of all of us to "let well enough alone;" but, if followed, this argument would lead us into a multitude of difficulties, engineering, legal and economic. The principal defect in the argument is that it overlooks one of the essential elements of a complete appropriation, to-wit: The element of place. This element of place, which is in every water decree,

means that the owner of a water priority must divert his water at only the place designated in the decree. An attempt to divert at any other point would be unlawful, would be forbidden by the water officials and enjoined by the courts.

Therefore, if a city or town were to wait for an emergency to arise it would be faced with the necessity not only of condemning water rights, but of getting a change of the point of diversion before such water rights could be used.

This naturally brings us to a consideration of suits for changes of points of diversion. The controlling principle underlying these suits is that no other water user must be injured by the change. Possible injuries to other water users are of three types.

(*a*) Injuries to water users higher up stream by requiring them to let down more water than they have in the past;

(*b*) Injuries to water users lower down stream by decreasing the amount of water which they will receive;

(*c*) Injuries to the owners of neighboring ditches by carrying around their points of diversion stream waters or return waters which they use.

One of the most important things to be remembered in suits of this character is that nearly all the early irrigation decrees in the arid states (or at least in Colorado) are much too large. In those early days adjudication cases were not greatly contested. The real value of the water was not known. Moreover, the early ditches, as a rule, never got very far away from the stream; and, if they diverted too much water, the excess soon returned to the stream as waste water or by seepage.

In order to meet the condition of these excess decrees the courts have formulated the legal principle that in suits for changes of points of diversion they will not necessarily permit the change of the entire amount of water specified in the decree; but only such portion thereof as is reasonably necessary for use on the lands where now used. Thus, if a water user has an irrigation decree for 25 second feet, and his land can get along with 10 second feet, the courts will only decree the transfer of the 10 second feet.

Moreover, in the case just supposed, if the water is to be carried a long distance from its original place of use, so that the return waters will not get back to the stream for other lower users, the court will not even permit the transfer of the entire 10 feet, but only such portion thereof as did not get back to the river by seepage.

To make this more clear let us suppose that farmer Jones has a decree for 25 second feet and has been diverting that amount; but the evidence shows that if he had diverted 10 second feet he would have had enough water for his land. In such case, the court would consider only the 10 feet for transfer.

Let us further suppose, in this case, that the evidence shows that if farmer Jones had applied the 10 feet to his land, 7 feet would get back to the river by seepage and be there used by being diverted by farmer Smith. In such case, if the return from the city's use of the water would be below the Smith land, the court would not decree the transfer of the 7 feet, if Smith protested; but only the transfer of the 3 feet which never gets back to the river.

It can be seen, in this case, that only 3 feet out of a decree of 25 feet would be transferred. This is not an extreme case.

Therefore, a city or town which waits for an emergency before acquiring water for future use, must be prepared not only to condemn water but also to take the hazard of transferring it. Condemnation plus transfer means years of costly litigation; and no city or town is justified in relying upon such doubtful expedients for its future water supply.

Moreover, a city or town must use its water throughout the entire year; while the irrigation use is only about seven months. Therefore, a city or town cannot provide its winter water by merely acquiring irrigation water.

CONCLUSION

It seems perfectly clear to me that a city or town must look years ahead in providing for its water supply; and that the authorities who are charged with the responsibility for the water supply of the city or town are recreant to their duty if they fail to make such provision.

In closing, I wish to say that, to my mind, the most hopeful element in the entire situation is that the use of water by a city or town is very largely non-consumptive. The city or town, after using the water, returns it to the stream through its sewers; and thus builds up the river for the irrigationists. When this fact is well understood, I look for the irrigationists to coöperate with the cities and towns and not oppose them (as in the past) in building for their future water supplies.

ELECTRIC PUMPAGE IN KANSAS CITY, MISSOURI[1]

By Albert L. Maillard[2]

In the new eleven million dollar addition to the water works of Kansas City, Missouri, there are included three pumping stations, one high lift and two low, all of which are electrically operated. Moreover, the power for these electrically driven pumps is purchased from the Kansas City Power and Light Company. The reason for purchasing power is a long story and will not be dwelt upon lengthily in this paper. Reference is here made to a paper by the writer entitled "Electric Pumpage in Kansas City, Missouri" published in the May, 1924, number of This Journal.

In the original studies made by Fuller and McClintock in 1920, steam driven pumps were considered for all stations. Later studies pointed to part steam and part electric drive. This latter scheme contemplated a high lift steam driven pumping station and electric power plant combined, thus confining all steam generation to one central location. The low head stations were to be electrically operated with power transmitted from the power plant. There were very good reasons for this change of plan. Among them were these:

1. The economical and best layout dictated two separate stations, a low lift to pump the water from the river to the purification works, and a secondary lift to pump the water through the tunnels to the reservoirs at the new and existing high head stations.
2. In consequence of the above each station had a capacity of about 2500 horse power, which is comparatively small for efficient steam generation.
3. There were several small pumps such as those needed for wash water, house service, etc., which would not lend themselves to economical steam drive.
4. The chemical plant, Dorr clarifiers, and sump pumps, cranes, etc., in addition to lighting, called for a great deal of electric power.
5. Due to the low floor elevation necessary at the low lift station the substructure was rather expensive. Steam drive with condenser and auxiliary equipment needed a great deal more room than did electric drive.
6. The losses in generating power and transmitting it would be offset by the better efficiencies gained in a centralized steam generating plant with larger units and lower unit labor costs.

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[1] Presented before the Missouri Valley Section meeting, October 5, 1928.

[2] Consulting Engineer, Kansas City, Mo.

The combined pumping and electrical loads at the high lift station in the East Bottoms were between 17,000 and 20,000 horse power. The cost of this combined station was estimated at about $3,000,000. The estimated cost of the entire additional works was approximately $20,000,000, but bonds were issued for only $11,000,000. Accordingly, some means of reducing costs had to be adopted. Purchased electric power offered a solution of pumping station economies in capital investment. The rates offered by the Kansas City Power and Light Company, when figured at certain load factors, compared very favorably with costs based on steam operation. Up to the present, however, these load factors have not been attained, due to a change of plan regarding the relative amounts of water pumped by the steam station at Turkey Creek and the electric station at East Bottoms, and the resultant power rate is not as low as was figured. Correspondingly so, operating costs at East Bottoms station for steam drive would have been affected had it been adopted.

Because of the fact that two local utilities competed with each other and with the consulting engineers' estimate of steam costs, a very interesting three-cornered fight ensued, with the result that the City was able to procure a contract that is unique in several ways, and rates that should result in an average cost of one cent per kilowatt hour if original load factors on electric pumpage be attained.

Some of the outstanding features of the contract are these:

1. That the City shall have first call on the power plants of the Company.
2. That duplicate feeders, of very liberal capacity, shall connect the stations with the power plant by two separate and independent routes.
3. That no other consumers shall be served by these feeders.
4. That no substations shall intervene between the pumping stations and the power plant.
5. That the established demand be calculated on a monthly average of half hour peaks rather than on an individual half hour.
6. That peak demands due to large fires, or emergency due to breakage of large mains, etc., be not considered in establishing the demand charge.
7. That the peak months for water pumpage, namely, June, July and August, be not considered in establishing the maximum demand but be treated as individual months.
8. That a credit or debit be allowed or charged with the fluctuations in the cost of fuel regarding a certain price as a base.
9. That a reduction in the demand charge be made based on 80 per cent power factor. Maintenance of 100 per cent power factor reduces the demand charge by 20 per cent.

Since the City has installed synchronous motors on all its major pumping equipment it is easy to maintain 100 per cent power factor. The following are the rates:

Demand charge:

$1.56–1/4 per month per kilowatt, plus $3,000 per month to cover charges on transmission lines.

Energy charge:

$0.007 per kilowatt hour until the demand at the high lift station exceeds 2,800 kilowatts.

$0.00675 per kilowatt hour until the demand at the high lift station exceeds 4,250 kilowatts.

$0.0065 per kilowatt hour until the demand at the high lift station exceeds 5,600 kilowatts.

$0.00625 thereafter.

The life of the contract is twenty years, but it may be terminated upon the giving of due notice by the City, should the Company fail to give first class service.

When steam drive was considered for the high lift station, 35 m.g.d. pumps were selected, but with electric drive, using synchronous motors, the capacity was changed to 24 m.g.d. contemplating six of the latter in place of four of the former. At the low and secondary lift stations 35 m.g.d. pumps were selected. One pump in each of these latter named stations, however, is equipped with a 20 m.g.d. impeller.

On account of the wide variation in head at the low and secondary lift stations the capacities stated are obtained only at average heads. The heads at the low lift station vary from 18 to 51 feet, while those at the secondary vary from 14 to 48 feet. These wide ranges of head presented quite a problem and the question of using two speed motors received considerable study. A careful examination of records of river stages covering several years of observation brought out the fact that during 80 per cent of the time the heads at the low lift station could be expected to vary between the limits of 39 and 48 feet, including suction lift. For the same percentage of the time it was found that the heads at the secondary lift station would vary between 32 and 44 feet. These estimates are based on normal operation of the works when supplying all of the needs of the city.

Based on the narrower limits of head variation, it was decided to use synchronous rather than two speed induction motors. The former had the advantage of better efficiencies during 80 per cent

of the time, better power factor at all times, less operating complications and slightly less cost; while the latter afforded better pump efficiencies for 20 per cent of the time. The power factor clause in the power contract was a determining factor in the decision.

MAIN PUMPING EQUIPMENT

The pumps at the low and secondary lift stations are of the double suction, single stage, volute type with 36-inch suction and 30-inch discharge nozzles. The casings are of cast iron, are split horizontally, with suction and discharge nozzles in the lower half and placed horizontally. The speed is 360 revolutions per minute. The short life of high speed impellers due to the cutting effect of the Missouri river sand was the reason for selecting such a low speed. For obvious reasons the same speed was selected for the secondary lift pumps.

Owing to the wide range of head under which these pumps were to operate, a minimum capacity of 32 m.g.d. was specified at 51 feet total head at the low lift station and at 48 feet total head at the secondary station. The manufacturers were asked to produce as flat a capacity curve as possible and were given three heads at which they were to make efficiency guarantees. The following is a tabulation of results obtained in field tests and which were somewhat better than those guaranteed:

TOTAL HEAD	CAPACITY	EFFICIENCY
feet	*m.g.d.*	*per cent*
32	44.0	80.5
38	40.5	84.5
44	36.0	86.0
48	32.1	

No efficiency guarantees were asked at 48 feet head. The above is the result of a test on one of the pumps at the secondary lift station and is typical of all the pumps at this station. The efficiencies of the pumps at the low lift station are somewhat higher, but both the efficiency and capacity curves have the same characteristic of flatness that is peculiar to those obtained from the pumps at the other station. The pumps in which the 20 m.g.d. impellers are installed show efficiencies varying from 2 to 3 per cent lower than those of the pumps with the larger impellers. Of course the 20 m.g.d. impellers are merely a temporary measure.

Summarizing, the main pumping equipment at the low and secondary lift stations comprises one 20 and three 35 m.g.d. pumps, with room for a future unit, in each station. Maximum head conditions at the low lift station occur when maximum demand and minimum river stage coincide. At the secondary lift station maximum head depends on demand, the elevations of the clear well and of the reservoirs at the high lift stations. Since at maximum heads the pump capacities are reduced to 32 and 18 m.g.d., the total capacity of the stations under maximum head conditions is about 114 m.g.d. It is not probable, however, that maximum demands at the low lift station will occur simultaneously with minimum river stage, for which reason this station capacity will be in excess of 114 m.g.d. during periods of maximum demand. At the secondary lift station all pumps were put on the line, the head was about 49 feet, and the total capacity of the station was 116 m.g.d.

Outside of the characteristics mentioned above there is nothing unusual about these pumps or about their installation and method of operation. They must be started against a closed discharge valve so as to keep the "pull in" torques of the motors down to a limit where best overall motor efficiency may be obtained. The pumps are primed by vacuum pumps, of the Nash Hytor type, two in each station. Those at the secondary lift station are controlled automatically by vacuum gauges acting on the motor controllers. The piping at both stations is so arranged that one or both vacuum pumps may be used to prime any of the main pumps.

AUXILIARY PUMPS

In addition to the main pumping equipment at the secondary lift station there are three wash water and four house service pumps. The former are of 2,500 g.p.m. capacity and operate against a head of 75 feet. Of the latter, two are of 500 and two of 250 g.p.m. capacity, all operating against 100 pounds pressure. The wash water pumps may be controlled from the filter galleries. The electrical control will be discussed later. The center lines of the pumps are at about elevation 23.0 and, since the clear well is normally kept above this elevation, the pumps are normally primed. The piping is such that the pumps discharge into the wash water tanks or directly into the filters depending upon the operation of certain valves. The house service pumps supply water to a tank the average elevation of which is about 230 feet. This tank furnishes pressure water for operating valves, for fire hydrants, for domestic and other uses about the plant.

The two pumps at the new high lift station, known as the East Bottoms pumping station, are of the horizontal shaft, two stage, type, consisting of two double suction, volute pumps connected for series operation. The series piping is located under the operating floor. The casings are of semisteel, split horizontally with suction and discharge nozzles in the lower half. Both nozzles are 20 inches in diameter, the suction pointing directly downwards and the discharge horizontally. These pumps are supposed to deliver 24 m.g.d. at 390 feet total head while running at 720 revolutions per minute. The following is a tabulation of results obtained in field tests on one of the pumps. The other showed slightly less capacity and efficiency, but the average of both pumps met the guarantees.

TOTAL HEAD	CAPACITY	EFFICIENCY
feet	*m.g.d.*	*per cent*
370	26.4	85.5
390	25.0	86.5
410	23.2	85.8

Since the initial installation, new 12 m.g.d. impellers have been installed in one of the pumping units. Recent field tests on this unit show the following:

TOTAL HEAD	CAPACITY	EFFICIENCY
feet	*m.g.d.*	*per cent*
370	13.4	82.75
380	12.8	82.50
390	12.2	82.50
400	11.65	82.50

There is nothing unusual about these pumping units. One great advantage that electric drive affords is that of the ease and speed with which a unit may be started and stopped. Normal operation provides a basin elevation that is high enough to make priming unnecessary. Omitting priming, a unit may be started and its full capacity placed on the line within one and one-half minutes. The shutting down process consumes but sixteen seconds, that is, from the time that the oil circuit breaker is tripped until the pump comes to rest and the check valve is closed. The sequence of operations will be discussed under the electrical features.

POWER SUPPLY

Since continuity of service is one of the prime requisites of the driving power for a direct pumpage system, it is necessary that the electrical layout provide sufficient duplication and flexibility to insure this service.

The entire works in North Kansas City are fed from an outdoor substation which is the property of the city. Power is obtained from the Kansas City Power and Light Company at 13,200 volts over two feeders, one overhead and the other underground. The substation equipment comprises two 2,500 k.v.a. banks of transformers connected delta-delta. Each transformer is rated 833 k.v.a., 13,200/2,300 volts, single phase, 60 cycles and is equipped with conservator and temperature indicator. These capacities were chosen on the basis that when overloaded 25 per cent one bank can carry 90 per cent of the ultimate load of the works.

The two incoming feeders form a loop and are protected by directional relays. The overhead line is provided with an oxide film arrester. Each bank of transformers is controlled by an oil circuit breaker on the high tension side as well as on the low tension side and is differentially protected. A tie line breaker on the high tension side provides flexibility while the low tension side is connected to a bus which is sectionalized by disconnecting switches. From this bus four feeders, two to each station, supply the low and secondary stations. Each station is fed by two feeders one from each section of the transformer low tension bus.

At this station the power is metered on the high tension side. Duplicate sets of metering transformers, one for the company and the other for the city, are installed on the structure. Duplicate sets of meters are located on the switchboard of the secondary station. The metering equipment consists of recording demand and power factor meters and integrating Watt hour meters.

Each of the main pumps in the low lift station is driven by a 400 horse power, unity power factor, synchronous motor operating at 2,300 volts, 3 phase, 60 cycles, 360 r.p.m. The excitation for these motors is supplied by two 30 kilowatts, 125 volts direct current, motor generator sets. Each set is capable of furnishing excitation for five motors. These sets may be used for lighting in case of failure of the lighting transformer.

The control for this electrical equipment comprises a fourteen panel

switchboard, the material of which is asbestos board, finished in natural black. This board is mounted on the gallery floor, 28 feet above the pump room floor. A mechanical remote control system through bell cranks and pull rods operates the oil circuit breakers which are supported on a pipe framework and located on another gallery 12 feet below the switchboard floor.

The main bus is sectionalized by two oil circuit breakers. In the section between these breakers there is connected a station service feeder which serves power, lighting and heating transformers. Each outside section of the bus is fed by an incoming feeder, each having the capacity of the entire station. One section serves two motors while the other serves the remaining two motors and will serve the future unit.

Motor starting is accomplished by means of compensators and a starting bus. This bus is sectionalized by disconnecting switches, each section being connected to a compensator. Each compensator has enough capacity to permit of four starting operations within ten minutes without excessive heating of the compensator.

Auxiliary power for operating vacuum pumps, sump pumps, motor generator sets, crane and gate valves in this building as well as the revolving screens in the intake is obtained from 3 to 25 k.v.a., 2300/230 volt transformers connected delta-delta. The lighting transformer is rated at 15 k.v.a., 2300/230/115 volts.

Both the intake and the low lift station are heated electrically and are served by a 150 k.v.a., 3 phase, 2300/230 volt transformer. Industrial oven type, 220 volt ribbon element heaters, suitably backed with reflecting and insulating material and provided with grillework in the front, are placed along the gallery in a manner similar to steam radiator practice. In most locations two elements are used to form one radiator, but they are individually controlled by local switches so that flexibility in controlling the heat may be obtained.

At the secondary lift station the main pumping equipment is a duplicate of that at the low lift station, consequently the electrical equipment is similar. The wash water pumps are driven by 75 h.p., 2300 volts, 3 phase, 60 cycle, 1800 r.p.m. squirrel cage induction motors. They are controlled by automatic "across-the-line" contactors and push button switches. The latter are located at three different places, one at the contactor and one in each filter gallery. The latter are connected in parallel with each other and in series with

that at the contactor. An oil circuit breaker controls each pump circuit. The 500 g.p.m. house service pumps are driven by 60 h.p., 2300 volts, squirrel cage induction motors which are started right across the line by merely closing the oil circuit breakers. The 250 g.p.m. house service pumps are driven by 25 h.p. 220 volts motors and are controlled by starting compensators.

In addition to these pumps all the power used in the Chemical House, Chlorine House, Filter House, Dorr Clarifiers and the lighting for all these buildings and the grounds are controlled from the switchboard in the secondary lift station.

The switchboard comprises twenty-one panels and the system is that of mechanical remote control with the main breakers and bus located in a room on the lower floor beneath the switchboard. The starting bus with its compensators and breakers are located at the back of the switchboard. The busses are sectionalized in a manner similar to those at the low lift station, but here there is one breaker for auxiliary power and one for lighting. There is no electric heating in this building.

The auxiliary power transformers comprise three 75 k.v.a., 2300/230 volt units connected delta-delta. Multiple lighting is served by a 75 k.v.a. 2300/230/115 volt transformer and series lighting by an 8 k.v.a. constant current transformer.

At the East Bottoms station the pumps are driven by 2000 horse power, 0.8 power factor (leading) 13,200 volts, 3 phase, 60 cycle, 720 r.p.m. synchronous motors. They are equipped with direct connected exciters which supply 125 volts to the fields. They are provided with temperature detectors of the resistance type and are equipped with enclosing end bells to cut down noise.

The switchboard comprises fourteen panels at present, but is expected to be expanded ultimately to twenty-one. The system is that of electrical remote control, some operations being performed manually while others are automatically controlled by relays and interlocks. The front of the switchboard faces the pump room while access to the back is had from the switch house. The material is asbestos board finished in natural black. All panels are of the same width, namely 24 inches.

With the exception of the auxiliary bus for light and power transformers, all busses, switching equipment, instrument transformers, compensators, etc., are enclosed in a monolithic concrete cell structure, with each phase in a separate cell. The auxiliary bus is mounted

on a structural steel frame work and is totally enclosed, the top and part of the sides being protected with transite board.

The station is fed by two underground lines direct from the company's power house bus. Ultimately there will be four such feeders. These feeders are installed in duct lines, each line taking a different route from the power house to the pumping station. The main bus in the station is in duplicate, but may be made one continuous bus by closing the tie breaker at one end of the bus structure.

Motor starting is accomplished by compensators and starting bus as in the other stations, but in addition "neutral" breakers are used to provide a smoother transition from starting to running voltage. Motors have 85 per cent pull in torque and full voltage is applied before the field circuit is closed.

The control circuit is fed by an MVSX Exide battery. A small motor generator set of 3 kilowatts furnishes the trickle charge for the battery.

At this point the sequence of operations in starting a motor might be interesting. First, the neutral breaker is closed manually, which automatically closes the compensator breaker. Next, the starting breaker is closed manually. An accelerating relay controls the next steps. As it closes, it trips the neutral breaker which automatically closes the running breaker. The field breaker is then closed manually and the compensator breaker tripped by hand, which operation automatically trips the starting breaker. If the field breaker be not closed within ten seconds after closure of the running breaker, the field failure relay trips the running breaker.

With the closing of the running breaker a solenoid valve on the automatic check valve is closed. This will be described more fully later. Due to the fact that this solenoid valve closes only after the running breaker is closed the motor "pulls in" against a closed discharge because the check valve cannot open while the solenoid valve is open.

In this station there is a 30 kilowatt motor generator set which performs four important functions. It can supply excitation for any one or two of the main motors. It provides a source of direct current for lighting in case of failure of the lighting transformer. It can give a full charge to the battery. It can provide current for the control circuit while the battery is out of service or being charged.

Auxiliaries are fed from a bank of three 25 k.v.a. 13,200/230 volt transformers. Lighting is supplied by a 25 k.v.a. 13,200/230/115 volt transformer. Emergency lights are fed from the battery.

AUTOMATIC VALVES

The description of this station would be incomplete without a word about the automatic stop and check valves. They are of the Johnston type and open and close automatically with unbalance of hydraulic conditions in the valve. The necessary unbalance of hydraulic conditions may be controlled by a solenoid operated valve in the blow off line of the main valve. The solenoid circuit is interlocked with the running breaker and a control switch on the switchboard is inserted in the circuit. With the closing of the running breaker the solenoid valve closes and permits the main valve to open as soon as the pressure on the pump side of the valve becomes greater than that on the line side. As soon as the running breaker trips out, the solenoid valve opens and the main valve closes. The control switch on the board permits the operator to open the solenoid valve circuit thereby opening the solenoid valve which in turn closes the main valve even with the pump operating at full speed. The operation of the main valve may be noted by the pressure gauge reading. This permits of the checking of one of the most important features of the station without disturbing normal operation.

The foregoing endeavors to describe, as fully as space will permit, the electrical and pumping equipment in the new works with special attention paid to the features which are unusual in waterworks practice. The use of 13,200 volt motors and electric radiators seem to be bold steps, and they are in waterworks practice, but in reality they are not new to the electrical industry.

It must be realized that when the works are put in full operation the city will be dependent entirely on electrical power for its water. Moreover, this electric power is being purchased from a public utility, namely, the Kansas City Power and Light Company. It is a great tribute to the reliability of electric public utility service and to the electrical industry as a whole. It is the writer's earnest hope that, as the years go by, no mishap will occur to shake the confidence so justifiably placed today.

THE WATER SOFTENING PLANT AT MARION, OHIO[1]

By George Whysall[2]

Upon numerous occasions the question has been raised why an attempt had been made to soften water supplied by wells and having a total hardness of from 40 to 51 grains per gallon, and if consideration had not first been given to another source of supply.

In the first place, a considerable sum of money had already been expended in the drilling and equipping of wells with the object of securing an ample supply of water from the limestone underlying the greater part of the district surrounding Marion. This water is and always has been of an exceptional character and no trace of typhoid fever has ever been found to have originated from the use of limestone water furnished by The Marion Water Company. Second, there is not available close to the plant a river supply sufficient to take care of the requirements, about 2.5 to 3 m.g.d.

The softening plant as designed contemplates a detention period long enough to drop out the maximum quantity of silt which is carried by a stream about 3 miles distant from the plant, the latter having a normal flow greater than the Marion requirements for some time to come. When designing this softening plant, we had in mind that additional storage was not only desirable but necessary. For that reason, larger tanks were erected than would have been the case had it been deemed advisable simply to soften the water and depend upon the soft water basin, which has a capacity of one million gallons. The raw collecting basin adjacent thereto is of the same capacity. As the plan worked out, we have two million gallons in the two basins and two million gallons in each of the two large tanks, so that there is available practically six million gallons, plus the combined capacity of the deep well pumps, four million gallons daily.

A two years' study was made of the different wells with the result that there was found a surprising difference in the water produced. The next discovery was that wells after several days shut-down,

[1] Presented before the Central States Section meeting, August 24, 1928.

[2] Vice-President and General Manager, The Marion Water Company, Marion, O.

produced a much harder water than when in continuous operation. This peculiar condition continues and no satisfactory reason for the irregular hardness of the water has been had. The writer has a hypothesis that the water is not traveling through the fissures and pores in the limestone for as great a distance as we have had in mind, and that when the wells are shut down the contact of the water with the limestone extends over a greater period of time, thereby giving the water a longer period in which to absorb limestone constituents which are soluble in water. When the wells are in continuous operation, the water is traveling more rapidly and has less time to absorb hardness.

We find that some wells are more consistent than others in that they produce a uniformly softer water than others. Consequently we have had to develop a schedule for well operation, bringing into service, first, those producing the softest water and as the demand on the plant increases, the next hardest wells are, in turn, brought into operation.

SELECTION OF TYPE OF SOFTENING PLANT

In the selection of the proper type of softening plant, it is essential to determine the ratio of carbonates of lime and magnesia to the sulphate hardness, which in our case is about 50 per cent. It was, therefore, concluded that the so-called lime-soda process should be adopted with provisions made for the future installation of green sand (Zeolite) filters for the purpose of eliminating the soda ash treatment and the substitution of the green sand—salt regeneration method. Estimates have been prepared covering this substitution treatment which indicate some saving. Water could then be delivered at zero hardness, or by remixing, at any total hardness desired.

We determined, before making the preliminary plan, to call in, for consultation, a widely known chemical engineer, Charles P. Hoover, one who was already familiar with some of our problems. The chemical end of the problem being worked out, it then became a matter of determining the capacity of the plant, 5,000,000 gallons daily, and the sequence of the several parts making up the unit. We did not follow this line very far, until it was determined to break away largely from what seemingly had become standard practice, and design a plant of such flexibility as to permit the use of the largest number of combinations.

CHEMICAL STORAGE TANKS

We first designed, therefore, the chemical house and instead of housing the two chemical storage tanks and supporting them on the walls of the building, we made the supports independent of the building and on their own foundations. These storage tanks are 16 feet in diameter and 30 feet high and will hold 215 tons each. They are closed over tightly at the top and project throughout their entire length above the roof of the chemical house. The bottom ends of these tanks are funnel shaped, provided with a hand operated slide gate which permits the material to be dropped directly into the weigh hoppers beneath. The tops of the weigh hoppers and the bottom of the tanks are connected with a muslin skirt or tube, which prevents the dust of the materials from escaping into the room. Immediately under the weigh hoppers are the Browning feeders and slakers. The feeders are very simple and consist of a cylinder through which a reciprocating piston operates, the motion being imparted to the piston from the center shaft of the slaker, stirring device, which is under the feeder. The feeders and slakers are motor-driven and are supplied with water to an extent which does not permit any increase of temperature through the slaking of the lime. We find this practice tends to decrease the annoyance of clogging of pipes. The lime and soda ash solution are removed from the slakers and forced into the mixing tank by means of a water ejector

MIXING TANKS

The mixing tanks are 30 feet in diameter and 23 feet 8 inches high and are so arranged that they may be operated in series or parallel, although experience so far indicates that series operation is more satisfactory. The water enters the mixing tanks on a tangent, thereby assisting the stirring mechanism to a considerable extent in the movement of the water. The stirring mechanism consists of paddles attached to the lower end of the vertical shaft and are set to operate quite close to the bottom. The weight of the vertical shaft and the driving mechanism is supported on ball bearings attached to a bridge extending across the top of the tanks. This bridge also carries the reduction gear and variable speed motors. The idea of having these stirring paddles driven by variable speed motors worked out just as we expected it would, in that we were in position to adjust the speed which would produce the desired velocity of the water within the tank. This scheme has worked out even better than we expected,

as there is but slight difference in velocity between the movement near the center and circumference of the tanks. Originally the lime solution was to be introduced through a nozzle on the tangential feed pipes. This method has been abandoned on account of the coating and clogging of the nozzle, which was 2½ inches in diameter, and the substitution therefore, of a 6-inch dip pipe which carries the lime solution over the top of the tank and down to a point in the zone of the feed pipe discharge. The soda ash solution was, for a time, introduced through a similar nozzle adjacent to the lime solution nozzle. But on account of the clogging of the connection, it has been re-located and we now discharge the soda ash solution through a dip pipe extending down about half way in the mixing tank. We have introduced the soda ash solution at different points in both mixing tanks, but practice indicates that both the lime and soda ash solutions should be introduced in the first tank, the latter at a point far enough above the lime to permit the lime reaction to become complete before the soda ash makes contact. This tends toward a more uniform effluent of the second tank as well as a better floc. As an experiment, we tried the introduction of a very small alum dosage into the mixing tank with the soda solution. This had a tendency to thicken the floc, but later we discovered a much better point for the introduction of the alum solution, 0.20 to 0.25 grain per gallon.

DORR CLARIFIER AND SETTLING TANKS

The effluent from the second mixing tank is carried through a 48-inch off-take which is supported from the bridge carrying the Dorr thickener or clarifier, and delivers the effluent into the feed-well of the clarifier tank. This feed-well is also supported from the bridge, is 30 feet in diameter and extends from above the surface of the water to a point within 10 feet of the bottom. Due to the extremely low velocity of the water on its way from the mixing tanks to the clarifier feed-well, a distance of 60 feet, the floc is fairly well settled toward the bottom of the off-take pipe, by the time it reached the feed-well. The water from this point seems to spread rather uniformly across the bottom of the tank, by which time the floc has all fallen out and the water rising around the outside of the clarifier tank is practically free of all suspended matter, the turbidity in fact being 2 p.p.m. Around the circumference of the clarifying tank is a trough or launder 4 feet deep and 3 feet wide. Its inner wall being a few inches below the level of the top edge of the tank, the water overflows

into the trough and is carried around in both directions to a point opposite the settling tank, which tank is equipped with a trough or launder similar to the one in the clarifying tank. Having gotten rid of the floc in the first tank, rough treatment of the effluent is immaterial, and for that reason, the settling tank is one foot lower than the clarifying tank. From the launder of the clarifying tank, the water is carried through an off-take to the feed-well of the settling tank. From here, as in the clarifying tank the water spreads across the bottom with no observable velocity, rises and overflows into a trough, or launder, and discharges into the carbonating tank, through a dip pipe extending to within 4 feet of the bottom. From this point, the water rises and passes out through an overflow to the soft water basin.

CARBONATION

The carbonating was originally done in the tank built for that purpose, but we soon found that the fine calcium carbonate particles, released by carbonation, were being carried through the soft water basin, into the distribution system.

It was decided to try carbonating in the feed-well of the settling tank, expecting, by this method, to give the fine suspended calcium carbonate ample time to settle. The results were very gratifying in that we found we could not only reach lower alkalinities, but could easily control the turbidity by adding 0.2 grain per gallon of sulphate of alumina.

RESULTS

The effluent from our settling basin now averages 0.5 p.p.m. turbidity where it previously ran as high as 10 to 15.

By careful operation of our carbonating system, we are able to reduce the total alkalinity from an average of 55 to about 35 in the settling tank.

Additional carbonating in the original carbonating tank brings the alkalinity down to an average of 30 and by the exercise of the greatest care, we can reach 23 to 25 p.p.m.

An analysis of the water at the various points throughout the system on a representative day is shown in table 1.

An interesting part of the lay-out is the method of unloading the lime and soda ash, received in bulk car load lots from which it is elevated by an "*Airveyor*," which is a vacuum method of elevating

the material into the storage tanks by means of vacuum of from 6 to 9 inches, the air and material being separated in a filter located on the top of the storage tanks.

TABLE 1

Typical analyses of water at different stations

		PARTS PER MILLION
Raw water	Carbonates	300
	Non-carbonates	400
	Total	700
Mixing tank effluent	Total alkalinity	55
	Phenolic alkalinity	40
	Caustic	25
	Non-carbonates	150
	Total	205
Clarifier	Total alkalinity	55
	Phenolic alkalinity	16
	Caustic	25
	Non-carbonates	150
	Total	205
Settling tank (after first carbonation)	Total alkalinity	35
	Phenolic alkalinity	16
	Caustic	0
	Non-carbonates	150
	Total	185
Carbonation tank (after second carbonation)	Total alkalinity	30
	Phenolic alkalinity	4
	Caustic	0
	Non-carbonates	150
	Total	180

STEEL VERSUS CONCRETE CONSTRUCTION

Much may be said on the advisability of concrete or steel construction for water softening plants. The writer is of the opinion that steel tanks are superior, in that changes in process can be made at little expense, whereas, in the case of concrete structures, flexibility, so needful for experimental purposes, is practically out of the question. Last, but not least, is the lower cost of the steel type with its

lighter foundations, than mass concrete construction with consequent heavy foundations.

The estimate on the softener plant was $157,000, but it was built for $147,000. Had it been built along standard lines, with costly foundations, the expenditure would have been at least $250,000.

DISCUSSION

D. E. DAVIS:[3] This paper has been of very great interest to me because it shows the progressive development in water softening which has been of tremendous interest. As Mr. Waring of the Ohio State Department of Health said this morning, there were comparatively few softening plants in Ohio other than Oberlin and Columbus until the past few years, and there are now a number of plants which I think have all been built in the last seven or eight years.

The course of the development in that period has been extraordinarily interesting, and can be illustrated, in a way, by the comparison of the period of time allowed for settling in some of the earlier plants compared with the present. As I recall it, at Columbus the period of settling in that plant, which was built twenty years ago, was about seventeen hours. The next plant cut that almost in half. The plant to which I refer was the Newark plant where it was about eight hours. The next was at Greenville, Ohio, where the period was cut to about three hours and a half.

One of the questions that I want to ask Mr. Whysall is, what is the present settling capacity of this plant as compared to the rate of the capacity of the plant as a whole.

Another thing I would like to inquire about is the increase in temperature of the water from the wells to the consumer. I assume that the water from the wells will have a fairly constant temperature throughout the year of somewhere between 55 and 60. This process, of course, is somewhat in the open, and in the summer-time I would anticipate some increase. I am just curious to know how much increase in temperature is found.

Another question that is of technical interest refers to the difference experienced in the mixing tanks due to changing the velocities. That is a question which, I think, is individual to each softening plant and no general answer can be given.

[3] Consulting Engineer, Pittsburgh, Pa.

I was interested to hear his statement that 3 feet peripheral speed is used at that plant. That compares with about 1 foot as being about the standard about two years ago, another indication of how fast these ideas are changing due to observation and experience.

Another detail of interest is that of the application of the various chemicals. Evidently in this case considerable benefit is obtained in savings in the cost of chemicals by applying the lime and the soda ash at different points. It may be interesting to learn how much saving is effected in that manner.

At the plant in Greenville, Ohio, with which I am familiar, we have a considerable amount of magnesium in the water, which we treat with lime to excess so that we obtain a causticity of fifty to seventy; in the final water we obtain a magnesium hydroxide which seems to act very much like aluminium hydroxide and is extremely gelatinous in character. It appears to have a considerable influence in carrying down not only the carbonates, but also to drag out of solution some of the sulphates, anywhere from 4 to about 10 parts. The average will run about 6. In other words, we are able to actually pick out of the water more than the chemical reaction would seem to call for. I wonder whether the same experience applies in Marion or whether the constituents of the water would not develop that same result.

Another question which I think might be interesting if Mr. Whysall developed it somewhat further, is the experience of his plant in the use of the excess lime method, carrying the water to causticity, and the result in terms of the pocketbook that that brings about.

I further recall in Mr. Waring's talk this morning that he claimed that to be one of the considerable contributions to the practice in the last year. It has almost revolutionized one form of softening in that it permits us to carry the final product to 30 or 40 p.p.m. lower than formerly with no increase in operating expense or chemicals.

MR. WHYSALL:[2] I am going to duck some of this and make the chemist in charge have something to say about it. However, I believe the velocity is governed somewhat by the depth of the vessel as well as its diameter.

We are using the excess lime treatment. At the same time it is a split treatment for we feed our lime and soda ash intermittently. It takes about an hour for the water to get through our basin and another hour through the other.

I am going to ask C. C. Whysall, our chemist, to answer the other questions.

C. C. WHYSALL:[4] In regard to the saving through the use of the excess lime treatment, the whole operation of this plant is based on that idea.

Our raw water has an average of about sixty parts of calcium carbonate and of magnesium carbonate. We add sufficient lime to throw down all the magnesium before we add the soda ash, with the idea that by doing this we will get rid of all the complex reactions that would occur if you added the soda ash and lime at the same time, for you would have the soda reacting with the magnesium. As my father stated, the lime is added just as the water enters the mixing tank. It then has almost an hour at our present rate of consumption before the soda ash is added.

You were speaking of the gelatinous mass due to magnesium. We add sufficient lime to get that gelatinous flock and we find just the results you spoke of, a reduction in the amount of soda ash necessary, and also a reduction in the sulphates. The soda ash is added about four feet down in the tank from the top through a dip pipe. The solution is carried up to this point with a water ejector and just falls down through the dip pipe, and the velocity of the rotating water carries it around. It has a fifteen or twenty minute mixing period in this first tank. Then it throws it to the center and it is carried through the tank down to the bottom of the second mixing tank and goes through the same rotating process, so that altogether our total mixing period is about two hours. The water as it comes in here then is treated in batches, a sort of a split treatment. We weigh our chemicals in the weigh-hopper and we have a beam scale. Every hour the operator sets the weights on this beam scale back the necessary amount. That is, say we are feeding three pounds per thousand gallons of soda ash. In pumping 60 gallons an hour he will set the scale back one hundred and eighty pounds, start the speeder, and let it run. When the one hundred and eighty are out he shuts off the feeder. That is the treated water. The rest of the water that goes through is untreated, but the law of mass action comes in and the part that is treated mixes with the untreated and the effect is as if the whole 60,000 gallons had been treated instead of just a small part. It really has been overtreated.

[4] Chemist in charge, The Marion Water Company, Marion, O.

The temperature the year round of the water from the wells is 54 degrees. We get about a five degree rise in temperature completely throughout the system until we get into the clear well and in there we get another degree, so that the water in our laboratory tap is about six degrees warmer than the well water. In the winter-time it is just the opposite, of course, depending on how cold the weather is, but it does not lose more than four or five degrees unless the weather is very extreme.

METER ACCURACY AND MAINTENANCE[1]

By W. H. Durbin[2]

The following discussion is based upon the installation of small sized meters of the displacement type and includes $\frac{5}{8}$, $\frac{3}{4}$, and 1 inch meters.

All such meters installed at Terre Haute are tested on a $\frac{1}{16}$-inch and a full stream. The average domestic pressure is from 45 to 50 pounds and the minimum test flow as noted will deliver approximately two-thirds of a gallon per minute. No new meter is placed in service without first running a test upon it. A meter that registers within 2 per cent plus or minus is considered correct, although it is our practice not to allow a meter to go in service that over-registers. The fact that the meter shows an over-registration usually reacts unfavorably on the utility even though the monetary consideration is practically negligible.

Our tests do not conform to the Standard Specification for Cold Water Meters as adopted by the American Water Works Association on June 19, 1921, which requires the following registration:

SIZE	NORMAL TEST FLOW LIMITS	MINIMUM TEST FLOW
inch	*gallons per minute*	*gallons per minute*
$\frac{5}{8}$	1–20	$\frac{1}{4}$
$\frac{5}{8}$	2–34	$\frac{1}{2}$
1	3–35	$\frac{3}{4}$

The normal test flow limit is to be within 2 per cent plus or minus, while the minimum test flow is to be not less than 90 per cent of the actual flow. Although not followed as a routine, minimum test flows of 1 gallon in 15 minutes or at the rate of 100 gallons per day have been made, and it is not uncommon for the $\frac{5}{8}$-inch meters to show a 90 per cent registration.

During the year 1927, 1678 meters were removed and tested.

[1] Presented before the Indiana Section meeting, March 16, 1928.

[2] Superintendent, Terre Haute Water Company, Terre Haute, Ind.

This figure did not include any of the new meters installed. Of this number 29.5 per cent were found to be stuck (includes meters damaged by hot water and frozen); 0.8 per cent over-registered more than 2 per cent; 7.2 per cent under-registered more than 2 per cent; while the number found correct within 2 per cent was 62.5 per cent.

TABLE 1

Tests made on ⅝-inch meters which have been in service from 10 to 13 years

No material used outside of gaskets, packing and change gears. Measuring chamber and piston not cleaned.

YEARS IN SERVICE	GALLONS REGISTERED	TEST BEFORE OPENING		TEST AFTER OVERHAULING	
		Full	⅛ inch	Full	⅛ inch
12	608,542	100	100	100	100
12	411,412	100	100	100	100
10		100	101	99	98
12	675,077	101	101	100	100
11		100	100	99	97
12	379,332	99	100	99	100
13		98	96	99	97
12	506,827	98	96	100	98
10		100	101	100	100
12	206,767	100	100	100	100
12	541,442	98	95	99	98
13	634,162	99	99	100	100
12	145,222	100	100	100	100
12	180,562	100	100	100	100
11	290,062	100	100	98	99
10		100	100	100	100
12	405,000	100	100	100	98
12	407,377	100	100	100	100
12	384,965	100	101	99	100
12	657,022	100	100	100	100
12	412,905	99	99	99	100

It has been the practice at Terre Haute to bill the customer for damages to the meter due to the action of hot water. All other maintenance is borne by the Water Company. During the year 1927, 86 meters were damaged by hot water. Of this number 62 were installed in basements and 24 at the curb line. It is also interesting to note that 78 meters were frozen, this number, 68 were installed in basements and 10 at the curb line. The total number of meters owned by the Water Company on December 31, 1927, ex-

clusive of the new meters that had never been placed in service, was 12,355, while the number of live accounts on that date was 12,041.

We have no set program as to when a meter should be removed and tested. We have in the past endeavored to establish an approximate test period of seven years, but this has been exceeded in a great many installations. From tests that have been made on meters in continuous service for a longer period than seven years and the consumption small, it would appear as if the length of time had but little to do with the accuracy of the meter. (See table 1.) It is our impression, therefore, that the consumption in the majority of cases should govern, rather than the period of service during which the meter has been installed. However, it is not as convenient in the small house meters to check the consumption as it is the length of service and, for this reason, changes are usually made upon the latter basis.

The total maintenance cost covering labor and material per 100 meters during the year 1927 was $31.29, which is based upon the average number of meters in active service for the year. The material cost was $10.22, while the labor cost was $21.07.

Tests made upon meters that have been in service for a considerable number of years invariably register very close to 100 per cent upon their removal. To compensate for the wear on the oscillating piston or disc and measuring chamber, a deposit or incrustation forms approximately equal to the wear that has taken place and the accuracy of the meter is maintained. If all of this deposit is removed, the meter will invariably fall off 2 or 3 per cent in its registration, and as typical of this, we cite the following cases:

Meter 1. An oscillating piston type. Years in service, 8. Total registration, 838,612 gallons. Test upon removal 100 per cent registration on $\frac{1}{16}$-inch stream ($\frac{3}{4}$ gallon per minute) and 99 per cent registration on full stream. The meter was then thoroughly cleaned and the test showed 95 per cent on the $\frac{1}{16}$-inch stream and 97 per cent on full stream, thus indicating a reduction of from 2 to 5 per cent.

Meter 2. A disc type. Years in service, 10. Gallons registered, 303,342. Test upon removal, 100 per cent registration on $\frac{1}{16}$-inch stream and 100 per cent on full stream. The meter was then thoroughly cleaned, all incrustation removed from the disc and measuring chamber and the test then showed 95 per cent upon $\frac{1}{16}$-inch stream and 97.5 per cent on the full stream. Both meters tested originally 100 per cent when set.

The question therefore arises, should the incrustation in the measuring chamber and on the piston be removed? Is it not better

to allow this to remain so that when the meter is placed back in service, it will still register approximately 100 per cent? If the incrustation is removed, the only way in which repairs can be properly made is to supply a new piston and possibly the bottom portion of the measuring chamber. The expense in such cases runs quite high and, in the end, have you a meter that will offer any closer registration than if this additional expense had not been incurred?

Where a meter has been in service and the test upon removal shows a registration within 2 per cent, it has been our practice not to clean the deposit from the measuring chamber and piston. If, however, the meter shows 97 per cent or less in its registration, our practice is then to give it a complete overhauling and usually this means a new piston, the lower portion of the measuring chamber, if of the oscillating piston type, as well as other needed repairs. We have on the 1- and 2-inch piston type meter turned down the bottom cylinder head in the lathe and were thus able to use the old one.

As to accuracy, our experience indicates that little difference exists between the oscillating piston and the nutating disc type, the advantage being possibly slightly in favor of the oscillating piston type construction. As to capacity, the disc type will deliver a considerably greater volume of water than the oscillating piston type. The tests made on meters removed indicate that the disc type has a greater tendency than the oscillating piston type to over-register after being in service, although this over-registration is the exception rather than the rule. When it comes to repairs we find that the cost of maintaining the disc is less than the piston type of meter.

Meters are tested when requested by the consumer, without charge, the only requirement being that the party requesting the test, or some representative of his, is to be present at the time this is made.

Approximately 55 per cent of our meters are placed in a housing at the curb line and 45 per cent in the basement. During the summer period it is not our practice to remove the meter as soon as the water service is discontinued. If, however, the premises remain idle for a month or more, an order is made for the removal of the meter.

THE STANDARDIZATION OF FIRE HOSE CONNECTIONS IN MONTANA[1]

By W. G. Brooks[2]

The fire losses in the United States for 1927 show that the total has been very materially decreased when compared with the seven previous years. In fact it is the lowest record since 1919, the figures for that year being $269,000,775 and for 1927, $320,595,600. When we consider the fact that the property value subject to fire loss has enormously increased during those seven years the figures for the past year are especially encouraging.

Yet there is not the slighest reason for the losses being what they are by millions. It is estimated by some writers that 70 per cent of the losses are due to carelessness. That would seem to be an excessive percentage, since some of the heaviest losses have been from causes such as lightning which were not due to carelessness. The unnecessary losses, however, have been far in excess of what they should have been, if the public had been careful.

The extensive use of wood in building in this country is, of course, a prolific cause of fires and heavy losses. As other non-combustible materials are being substituted for wood the fire losses will fall. That is amply illustrated by the fact that in one South American country fire insurance is not needed because the houses are largely built of adobe or non-combustible material, and not because the inhabitants are any more careful of fire than they are in the United States.

Our climate also has much to do with fire losses, since it entails the need for more fires. Yet the fires in New York with its intense winters showed a very notable decrease both in the number of fires and in the amount of loss.

The campaign, then, for fire prevention should go on energetically. One excellent suggestion was that the fire departments in the cities be employed in preventing rather than in extinguishing fires. In

[1] Presented before the Montana Section meeting, March 10, 1928.

[2] State Fire Marshal, Helena, Mont.

other words, the firemen should be employed in making a thorough and continuous examination of houses, stores, etc., to see that they were properly guarded against fire.

The losses by forest fires have dropped considerably during the past twelve months and that has reduced the total for the year. A system is also said to have been devised for the protection of "tank farms" for the storage of oil from lightning. In short, the good work of reducing fire losses goes on apace and we trust that the figures for 1928 will be still better than those for the year just passed.

Statisticians placed the life loss caused by fire during 1926 at 10,000. This is a reduction of about 34 per cent in the last three years, largely due to the extensive educational work carried on in the interest of fire prevention. There has been a serious increase, however, in the number of persons injured, as the statistics available show an average of two persons injured to one killed. This, on the basis of our estimate, would show at least 20,000 persons injured by fire. The largest percentage of both killed and injured are of the dependent class, namely, mothers, children, the sick in hospitals and the unfortunates in institutions. It is also noticeable that a large percentage of casualties are among those engaged in fire service.

Municipal and state improvements depend upon taxes for their sustenance. When a building is burned it can no longer be taxed, and the tax it would have produced is paid by the remaining taxpayers. Nearly $21,000,000 will be paid by others this year because of last year's fire waste.

It is impossible to estimate the economic loss which comes as a result of fire. It includes all interruptions of business, loss of contracts, annihilation of sales force and loss of clientele. It stops the pay check for the employes.

Figures are given herein on the six predominating causes of fire, as reported by the Actuarial Bureau of the National Board of Fire Underwriters. Twenty-five per cent is added for fires in un-insured property and losses not reported to the Actuarial Bureau.

Matches, cigars, cigarettes and other "smokes" started fires causing a loss of $37,880,000. These can be prevented by the development of careful habits with matches and smokes, good housekeeping, which prevents rubbish accumulating into which the carelessly discarded match can fall, and proper physical safeguards around the handling of flammable and explosive substances.

Defective chimneys and flues were responsible for $27,092,000 loss,

and stoves, furnaces, boilers and their pipes caused a loss of $24,521,000.

These fires are entirely preventable. Chimneys can be built right, kept clean and in repair. Heating apparatus can be installed at no increased expense so that it will never cause fire.

Spontaneous ignition is given as the cause of fires costing $21,739,000 loss. Many of these fires originated in oily or paint-smeared rags, oil mops and the like. These fires can be prevented by not allowing oily rags to accumulate, and by keeping oil mops in metal boxes.

Sparks on roofs destroyed $18,350,000 worth of property. These losses are wholly preventable by the use of fire retardant roof coverings. If your city does not prohibit wooden shingles by ordinance, it should do so.

Electricity and electrical appliances caused a loss of $18,961,000. Of all these fires, 46⅔ per cent were due to carelessness with electric flat-irons. Much of the remaining electrical loss was the result of improper wiring and overloading of circuits. Electrical fires are largely preventable by proper wiring installations and by care in the use of irons and other electrical devices. Only 4 per cent of electrical losses are found in buildings wired according to the National Electrical Code.

In the past fifty years, while the increase in population has been 150 per cent, that of fire losses has been 63 per cent. In 1870 the fire loss average was $19 a minute; today the figure is $1,066.

The Committee on Safety to Life of the National Fire Protection Association recently stated that 50 per cent of the educational institutions of the country were unsafe. We teach school children fire prevention, and yet in many cases they are taught the doctrine in a fire trap. Is this economics or humanity?

STANDARDIZED HOSE COUPLINGS

Within the memory of all there have been numerous conflagrations in which outside assistance was of no avail because the hose couplings of neighboring fire departments would not connect to local hydrants. The most important example of this was the great Baltimore fire of 1904. When the Baltimore fire department found that the conflagration was getting beyond control they called upon Washington, Philadelphia and New York for help. The railroads cleared their tracks and special trains carrying fire apparatus were rushed to

Baltimore. The fire-fighting apparatus from these three cities were on the ground in a remarkably short time, but the hose could not be connected to the hydrants and the hose couplings did not fit. Thus fire-fighting apparatus which had been brought from a considerable distance either functioned inefficiently or stood idly by while Baltimore burned.

The great city and small village are alike menaced. It is not only in such great conflagrations as those of Chicago, in 1871, Boston in 1872 and Baltimore in 1904 that such conditions have led to disaster. They play an important part in many of the fires that cause an annual loss of more than $348,000,000. For example, lack of interchangeability in couplings was a large factor in the conflagrations in Salem, Mass., in 1914; Paris, Texas, in 1916; Augusta, Georgia, in 1916; Atlanta, Georgia, in 1917; Thomsonville, Georgia, in 1918; Mobile, Ala., in 1919; Worcester, Mass., in 1921; Pocomoke City, Md., in 1922; and Grimes, Iowa, in 1923. The same difficulty is frequently experienced in smaller towns which do not have the same coupling threads as do their larger neighbors; e.g., the fires in Rising Sun, Md., in 1921; Ellicott City, Md., in 1923; and Farmington, Conn., in 1923.

The manufacturers and distributors of fire-fighting equipment such as fire engine suction and discharge connections, fire hose and couplings, hydrant outlets and special connections of all kinds, are vitally concerned in the success of the movement to standardize all hose connections. With the universal adoption of the National (American) Standard Fire-Hose Coupling Screw Thread by the towns and cities of the United States these important elements of fire-fighting equipment will be produced in quantity rather than on order, a condition which will greatly reduce the manufacturing cost and facilitate their distribution.

Under present conditions with less than one-half of the country's fire fighting apparatus made to the national standard the manufacturers of these attachments are compelled to preserve in their factories, sample fittings from all of the towns and cities which they serve with their product. One manufacturer is known to hold from 500 to 600 such samples against possible orders. These samples so vary in dimensions and number of threads per inch that each order, for instance, must be treated separately from all other orders thus making it impossible to introduce quantity production methods.

In a word, the public loses a large amount of fire protection by the use of non-standard couplings and is compelled to pay a higher price for the equipment because of the expensive methods of manufacture.

The movement to bring about the general adoption of the National (American) Standard Fire-Hose Coupling Screw Thread has gained such momentum during the past few years, we shall assume for the purposes of this discussion that the reader's town or city has officially adopted the national standard. If this is not the case, such official adoption is the first step in this important matter and the second consists in the resizing of the present threads on hose couplings, hydrant outlets, and special fittings. This can now be done at a moderate expense by means of sets of standardizing or salvaging tools. For further information on this point, you may consult the National Board of Fire Underwriters, 76 William St., New York.

The official adoption of the national standard and the resizing of existing equipment will not insure for all time the going together of the fire-hose fittings of any community. This can only be accomplished by eternal vigilance which begins with careful inspection of all the threads of each and every new lot of fire hose and fire hydrants as they are purchased. It is perfectly obvious that this inspection must be also more than a casual examination of the threads and the screwing on of an old mating part of the new coupling or nipple. It is conceivable that such a procedure might except new fire hose or fire hydrants which would not mate with one-half of the fire department's equipment.

Old couplings, hydrant nipples, or cast-iron hydrant caps are not reliable as test pieces or specimens owing to wear and corrosion. Modern manufacturing processes call for the use of hardened steel models or final inspection gages by the manufacturers, and hardened steel models or field inspection gages by the persons responsible for accepting the equipment. It was not, however, until the nation-wide standardization program gained its present headway that the production of these hardened steel gages became economically possible. They may now be obtained at moderate cost from the following five gage manufacturing concerns:

Greenfield Tap and Die Corporation, Greenfield, Mass.
Pratt and Whitney Company, Hartford, Conn.
Taft-Pierce Company, Woonsocket, R. I.
The Threadwell Tool Company, Greenfield, Mass.
Sheffield Machine and Tool Company, Dayton, Ohio.

A set of standard field inspection gages consists of six pieces, three to gage the coupling or internal thread and three to gage the nipple or external thread. The first three consist of a "Go" plug-thread

gage, a "Not Go" plug-thread gage and a "Not Go" plug plain cylindrical gage. The second group consists of a "Go" ring-thread gage, a "Not Go" ring-thread gage and a "Not Go" sign ring plain cylindrical gage. All three of the ring gages should be non-adjustable. When applied to the threaded parts of a coupling the "Go" thread gages, both plug and ring, insure that all parts which pass this inspection will go together and will never be too tight. This test consists in screwing the gages on the parts being tested covering the full length of the thread. The "Not Go" thread gages, on the other hand, are used to make sure that the parts will not produce a joint which is too loose. These gages should jam at about the second thread. The "Not Go" plug and ring plain cylindrical gages check the height of the thread which means the depth of engagement.

The field inspection gages purchased from the five firms mentioned above may be depended upon to agree with the national standard. Should it seem desirable at any time, however, to have them checked, the Gage Section of the Bureau of Standards, Washington, D. C., is equipped to do this work. The final inspection gages used by the manufacturers may also be tested by the Bureau of Standards.

The following are the listed characteristics of the National (American) Standard Fire Hose Coupling Screw Thread:

	NOMINAL INSIDE DIAMETER OF HOSE COUPLING			
	2½ inches	3 inches	3½ inches	4½ inches
Number of threads per inch	7½	6	6	4
Total length of threaded part of coupling and hydrant nipple external thread, inches	1	1⅛	1⅛	1¼
Distance from face of nipple to start of second turn, inches	¼	5/16	5/16	7/16
Depth of coupling swivel to washer seat, inches	15/16	11/16	11/16	13/16
Distance from face of coupling swivel to start of second turn, inches	3/16	¼	¼	⅜
Depth of coupling swivel thread from face of swivel, inches	11/16	13/16	13/16	15/16

We plan therefore to prepare a state law for the next legislative assembly (1929) to make possible the purchase of a set of reamers, taps, dies and spanners and to employ a man with a car to take it to

each city and town and there, in coöperation with the local fire departments, to change the threads of all connections to the standard.

Following this we hope, by law, to make it compulsory upon each city and town to purchase all new equipment to correspond to the standard and to make it illegal for an equipment company to sell other than the standard.

DISCUSSION

MR. THANE: Is there a difference between the national thread and the Pacific Coast standard?

MR. BROOKS: No.

MR. THANE: The Pacific Coast standard is the one we are adapting to the state.

MEMBER: The national is seven and one-half threads to the inch?

MR. BROOKS: Yes, sir.

MEMBER: We use that in Butte. That is the standard.

MR. THANE: Is the Western the same as the Pacific Coast standard?

MR. BROOKS: Yes, sir.

MR. THANE: I understood you to say the Pacific Coast and the national standards were the same?

MR. BROOKS: I believe they are. There is a difference, Mr. Thomas says. Well, the idea is to adopt the national standard of seven and one-half threads.

MR. THOMAS: I do know that the standardization of hose threads is being considered by the National Board of Underwriters. That is the thing they are devoting most of their attention to at the present time. In the States of Washington, Oregon and Idaho they are standardizing the threads of the different communities. Fifty-three

companies responded for aid in the Baltimore fire, but they could not use all the equipment. The national standard thread has been studied by the National Board of Engineers and in the American Society of Mechanical Engineers. It is really, as nearly as they can make it, a composite of nearly all the threads in actual use. I do not think it would take very much work to standardize the threads. I am sorry Mr. Johnson, of Anaconda, is not here. They standardized there two or three years ago. The different communities should coöperate and standardize the threads on their hydrants and their hose under the supervision of the State Fire Marshal, and the resolution that Mr. Brooks would like to have is that this Association go on record as considering that work of value. The standardizing of hose threads must be more economical in the purchasing of equipment. I was informed by Mr. Andrews, of the National Board of Fire Underwriters, that one hose salesman told him his company had to keep in stock forty thousand dollars worth of brass goods to supply the difference in threads. Of course, you know who pays. By having this single standard you would secure more uniform work. You send in your coupling to the manufacturer, but that is no assurance you are going to get a good thread. The standardization of hose is considered the biggest work before the National Board at the present time.

MR. CORTESE: Every water department and fire department in the country should coöperate in the standardizing of threads. We had a little incident in Livingston three or four years ago. We were called upon by the City of Bozeman for some relief. They had quite a bad fire. We had a special train take us to Bozeman, we took our hose and our nozzles and a considerable number of men, and after we got there our equipment was absolutely useless. Fortunately it was not a matter of equipment, it was a matter of man power. Here were two towns, approximately 25 miles apart, which could have been a lot of help to each other, but due to a variety of threads were absolutely useless to each other. Ours is seven and a half to the inch and unfortunately in Bozeman they have the 7 inch. The change could be made very easily by getting a set of dies.

PROGRESS REPORT OF SECTIONAL COMMITTEE ON SPECIFICATIONS FOR CAST IRON PIPE AND SPECIAL CASTINGS

The Sectional Committee on Specifications for Cast Iron Pipe was organized in 1926 under the auspices of the American Engineering Standards Committee, which has recently become the American Standards Association, and this Sectional Committee was sponsored by the following four societies:

American Gas Association
American Society for Testing Materials
American Water Works Assocation
New England Water Works Association

The Sectional Committee consists of thirty-nine men representing producers, consumers and others having general interest in the subject. The Sectional Committee has organized three Technical Committees and other men have been added to membership of the Technical Committees and their Sub-Committees resulting in a total membership of over one hundred men.

In the work of preparing new standards for cast iron pipe and special castings, the Sectional Committee lays down scope and program for the work, dividing it among the Technical and Sub-Committees, who in turn prepare their part of the Specifications and submit them to the Sectional Committee for review, criticism, changes and adoption.

There are three Technical Committees: No. 1 on Dimensions; No. 2 on Metallurgy, Processes and Tests; and No. 3 on Corrosion and Protective Coatings.

TECHNICAL COMMITTEE 1. ON DIMENSIONS

To this Committee has been assigned the work of reviewing schedules of dimensions and weights of pipe and fittings of the kind included in the scope of the Sectional Committee. It will seek to simplify the schedules by eliminating unnecessary sizes, weights and patterns. It will carry on such tests and investigations as may be required to deter-

mine mooted questions such as proper thicknesses of barrels of pipe, the strength of bells under trench loads and water pressure, strength of fittings under water pressure, etc.

Sub-Committee 1-A. On Barrel of Sand Cast Pipe

This Sub-Committee will consider present needs in thickness of barrel to resist static and water ram pressures, external pressures from earth and vehicular loads, stresses due to handling, to improper supports, to projecting ledge and frozen ground, question of outside diameter, etc. It is intended that tests on stresses in barrel of pipe shall be made.

Sub-Committee 1-B. On Bell and Spigot Dimensions of Cast Iron Pipe Including Lugs and Harnesses

This Sub-Committee will consider possible improvements in design of bells to resist stresses due to caulking, settlement, etc., and the design of lugs and harnesses.

Sub-Committee 1-C. To Consider All Types of Pipe Other Than Sand Cast

This Sub-Committee will consider various kinds of pipes cast in rotating molds, Universal, McWane, and other kinds of pipe not cast in vertical fixed sand molds.

Sub-Committee 1-D. On Fittings

This Sub-Committee will consider fittings of all kinds; reduction, if possible, in their number and variety; strength of tees, crosses, Y-branches and sharp curves which on account of their shape are subject to special stresses from hydraulic pressure. Tests may be made.

TECHNICAL COMMITTEE 2. ON METALLURGY, PROCESSES AND TESTS

To this Committee has been given the task of investigating pig iron and other raw materials entering into cast iron for pipes, melting practice in the casting of pipes, and acceptance tests relating to the strength of the pipes and the quality of metal in them.

Sub-Committee 2-A. Raw Materials and Melting Practice

This Sub-Committee will consider materials entering into the manufacture of cast iron pipe up to and including the molten state. If this Committee should decide that it is not desirable to specify actual

composition of the melt it should so report and give its reasons therefor.

The apparently injurious effects on the quality of cast iron caused by forced output from blast furnaces and from some cupolas, the quality of some domestic and imported pig iron now on the market, practical limits in the use of scrap of various kinds and quality of coke and limestone are some of the questions to be considered by Sub-Committee 2-A.

Sub-Committee 2-B. Metallurgy and Chemistry

This Sub-Committee has the following assignments:

(*a*) To make all chemical analyses of metals for the Sectional Committee, Technical Committees, and Sub-Committees.

(*b*) To consider desirability of chemical specifications in general for composition of metal in the finished castings.

Sub-Committee 2-C. Physical Tests and Test Specimens

This Sub-Committee has the task:

(*a*) To study the question of test bars, test specimens and other physical acceptance tests for pipe, and carry on such experimental testing in relation to acceptance tests as may be recommended by itself and approved by the Executive Committee, or as the Executive Committee may request it to do. An extension of the Talbot Tests to other sizes of pipe is one of the suggested lines of study.

(*b*) The study shall include the collection and analysis of test bar data and experience with test bars and other specimens to date; the study of the relationship of the strength and deflection of bars to the desirable and undesirable properties of pipe as shown by experience; and the study of the propriety of substituting the new Arbitration Bar for the 2-inch and 1-inch bar.

Sub-Committee 2-D. Experience

This Sub-Committee has the following assignment:

To assemble and analyze data on experience with pipe and failures by fracture in service with particular relation to evidence as to failures resulting from quality of iron or processes used. (Study of injury and failures from corrosion is assigned to Technical Committee (3).

TECHNICAL COMMITTEE 3. CORROSION AND PROTECTIVE COATINGS

To this Committee has been assigned the study of causes and mechanism of the corrosion of cast iron pipe exposed to soil or water, and of

practicable methods of reducing or eliminating such corrosion *so far as this can be done at the pipe shop.* It will prepare specifications for coating and for any other pipe shop procedure which it may find it necessary and practicable to control in the interest of better resistance to corrosion, and economically justified by the results. It will make such investigations, experiments and tests as may be necessary to the above ends.

Control of corrosion by treatment of soil or water, field coatings, metallic coatings, and corrosion due to stray-current electrolysis are outside the province of this Committee.

Sub-Committee 3-A. Theory of Corrosion of Cast Iron Pipe

This Sub-Committee has the following assignment:

To ascertain the causes and the mechanism of the corrosion of cast iron pipe by water, the chemical and physical properties of the metal in the finished pipe which accelerate or inhibit corrosion, and how and to what extent it is technically and commercially practicable to reduce corrosion by control of foundry procedure, other than by coatings.

Sub-Committee 3-B. Organic Coatings (Coal Tar, Asphalt, etc.)

This Sub-Committee has the following assignment:

The preparation of specifications for the coating of cast iron pipe and fittings at the pipe shop with organic materials. "Organic Materials" are interpreted to include coal tar pitch dips, asphalt dips, coal tar "enamels" such as, "bitumastic," etc., asphaltic dips and enamels, thick coatings or linings of bitumen and mineral filler; they also include organic cold paints and varnishes for use in those special cases where hot dipping is impracticable.

Sub-Committee 3-C. Inorganic Coatings (Cement Linings, etc.)

This Sub-Committee has the following assignment:

The preparation of specifications for the cement lining and coating of cast iron pipe and fittings, including mortar and concrete and other inorganic linings and coatings, if any, excluding, however, purely metallic coatings.

Sub-Committee 3-D. Water Corrosion Experience

This Sub-Committee has the following assignment:

To collect and digest the experience of pipe users with water corrosion of cast iron pipe and correlate that experience with the proper-

ties of the iron, the water, and the coatings. To study the territorial extent of water corrosion troubles, the annual tonnage of pipe affected, and what internal corrosion, pitting and tuberculation have cost the pipe users.

Sub-Committee 3-E. Soil Corrosion

This Sub-Committee has the following assignment:

To collect and digest the experience of pipe users with soil corrosion of cast iron pipe not caused by stray current electrolysis, and to correlate that experience with the properties of the iron, the soil, and the coatings. To study the territorial extent of soil corrosion troubles, the annual tonnage affected, the cost to the pipe user, and what he can afford to pay to avoid or minimize soil corrosion. To study the causes and mechanism of soil corrosion with a view to determining the pipe shop procedure and precautions in transportation and handling that will minimize such corrosion uncoated or shop-coated pipe.

Sub-Committee 3-F. Hydraulics (Carrying Capacity of Cast Iron Pipe with Different Coatings at Different Ages, etc., What Consumer Can Afford to Pay for Better Coatings

The sole purpose of an investment in a line of cast iron water pipe being to purchase carrying capacity, and the full capacity generally not being required for many years after laying, this Committee will have the following assignment:

To determine the relative carrying capacities of cast iron pipe with various coatings, both new and after exposure to active waters, the coatings to include ordinary coal-tar dip, coal-tar dip as it may be improved, cement linings, and any other coatings which may show sufficient promise to warrant investigation. To determine the necessary over-size of pipes variously coated to give the same capacity at various ages in active waters as a corrosion-free and tuberculation-free pipe, and to estimate the money value of the better coating. To organize field or laboratory gagings, if found necessary or desirable, and to advise respecting any other hydraulic aspects of the corrosion and coating problem.

QUESTIONNAIRE

A great deal of the information to be collected by this Sectional Committee is being obtained by means of a questionnaire which has been sent to over one thousand superintendents of water and gas

plants, and the returns so far received show that much and valuable information is being obtained, much of it of a nature never before collected and which will deserve very careful study and require much work on account of its volume. The questions in the questionnaire are grouped under the following headings:

1. General information
2. Dimensions
3. Failure of pipe
4. Barrel of vertically sand cast pipe
5. Bell and spigot joints for vertically sand cast pipe
6. Special types of pipes
7. Fittings
8. Metallurgy and tests
9. Internal corrosion
10. Bituminous coatings
11. Cement linings and coatings
12. Soil corrosion
13. Hydraulics

The questionnaire is soliciting views of the best men, both superintendents or operators and consulting engineers concerned with cast iron pipe from all three aspects, production, use and general interest, as to such changes in specifications as they would advise, and valuable information of their experience in the use of pipe of various kinds is being obtained.

TRENCH LOAD TESTS OF PIPE

Under the direction of Technical Committee 1, trench load tests are being made at Iowa State College which will give definite information to an extent never before realized on some of the questions on earth loads on which there has been much discussion in the past. Work is under way on tests on the supporting strength of 8-inch and 20-inch pipe with and without internal pressures with different arrangements of bearings, both of single pieces and of jointed pieces, which will give better knowledge of the stresses in the pipe when in the ground under normal earth loads, under heavy cover, and when the support under the pipe is for any reason poor.

The quality of the metal in the pipes used in these trench load tests is determined from the following data:

Record of tests of 2-inch by 1-inch bars cast from the heat. Statement by foundry making the pipe, of the make-up of the charge, size of cupola, air pressure and quantity of air, rate of melting.

Chemical analysis, if available, of metal from casting of similar thickness from same heat.

Strength tests will be made on the pipes used in the trench load tests by means of:

Series A. Rings 1 inch wide.

Beam test pieces—the thickness of the pipe, with skin on sides, as used in the Talbot tests; and other pieces with skin at top and bottom.

Tension pieces both of standard form and with skin on.

Charpy impact tests.

The program for trench load tests includes:

I. Tests of the Supporting Strengths of 20-inch pipe with and without Internal Pressures

Series B. Tests of Supporting Strengths of Lengths about 4 feet long using standard "three edge" bearings; 20-inch Class B pipe; internal pressures 100, 300 and 600 feet.

Series C. Tests of Supporting Strengths of Lengths about four feet long, using combination of "three edge" and "sand bearings," corresponding to pipe supported on a flat bottomed trench, and loaded by the ditch filling material, without backfilling; 20-inch Class B pipe; internal pressures 0, 100, 300 and 600 feet.

Series D. Tests of Supporting Strengths of Lengths about 4 feet long, using "sand bearings," corresponding to pipe in a trench with the bottom hollowed out so as to support 60 to 90 degrees of the bottom of the pipe, and loaded by the ditch filling materials; 20 inch Class B pipe; internal pressures 0, 100, 300 and 600 feet, as judged from previous tests to be most informative.

Series E. Tests of Supporting Strengths of Jointed Specimens 20 feet long, supported on blocking and loaded through an upper sand bearing to represent load due to ditchfilling materials; 20-inch Class B pipe; internal pressures 0, 100, 300 and 600 feet, as judged from previous tests to be most informative.

II. Tests with Small Pipe as Beams in Trenches

Series F. Supporting Strengths of 8-inch pipe in trenches in natural soil supported on blocks and loaded with superimposed load to represent truck wheel or road roller over the mid-length of the pipe; earth cover 2 feet and 3½ ft.; pipe, gas pipe and Class B water pipe.

Series G. Tests of Supporting Strengths of two lengths, jointed, and supported on blocks at extreme ends of jointed length, using upper sand bearing to represent load from filling material; 8-inch Class B pipe; lead, leadite and lead hydrotite for the joints.

TESTS OF STRENGTH OF PIPE

Under the direction of Technical Committee two tests are under way at the University of Illinois on strength of pipe, using methods similar to those used previously at this University by Professor Talbot, whose results were published in 1926 in the Journal of the American Water Works Association and in the Proceedings of the American Society for Testing Materials. The new methods of testing, inaugurated by Professor Talbot, have increased knowledge of the properties of cast iron pipe and the tests now being conducted by this Committee on 20-inch pipe, using methods similar to those used by Professor Talbot on 6-inch pipe, together with some new methods of test developed by Professor M. L. Enger, now being used by this Committee for the first time, will be of great value.

These tests include:

Internal pressure tests, including measurement of expansion of specimen while under test
Falling ring impact tests
Compression tests on full rings
Compression tests on half rings
Tension tests on half rings
Flexure tests on rings with loads applied at six points equally spaced
Charpy impact tests
Brinnell hardness tests

TESTS ON WATER CORROSION OF PIPE

Under the direction of Technical Committee 3, tests are in progress at the Massachusetts Institute of Technology on corrosion in water of cast iron pipe of various chemical compositions, the specimen being kept immersed up to a maximum time, under the program, of 300 days, and the water being allowed to run without interruption past the specimens which are kept rotating. Knowledge gained from the loss in weight of the pipe from water corrosion and from its appearance and character of corrosion, taking into account the constituents of the metal and the nature of the water, will give valuable information in regard to both pipe and coating.

ALL TESTS

On all of these tests the pipes come from foundries in different parts of the country and are not specimens picked for the tests, but are the ordinary run of pipe, with the view that all tests should give information which will apply to average conditions. Complete information is recorded of all details of manufacture of each piece of pipe so that everything possible will be learned and published to connect cause and effect of all phenomena observed. Published reports will be made of the information available from the tests, from the questionnaire and otherwise, without waiting for the issuance of a final report, so that all information obtained will be available to those interested as completely and as early as possible. Through the generous and enlightened policy of the producers and certain of the users, over $60,000 has been made available for use in the research activities of the Sectional Committee. Most of this has been contributed by the producers.

A. V. RUGGLES,
Executive Assistant to Chairman.

PRESSURES IN MANIFOLD PIPES[1]

By M. L. Enger[2] and M. I. Levy[3]

The effect of the momentum of the water on the pressures and flow in manifold pipes and in perforated pipe underdrains used in rapid sand filters, has long engaged the attention of designers. Mr. J. W. Ellms recently[4] presented a paper giving the results of experiments on perforated pipes and stating rules for design.

An extreme case of the variation of pressure and discharge from a manifold pipe is shown in figure 1, which is from a photograph taken in the Hydraulics Laboratory of the University of Illinois. A diagrammatic sketch of the arrangement used is shown in figure 2. Ten 2-inch pipes, each 36 inches long, are connected to a manifold pipe lined with cement to make its inside diameter 2 inches. On the ends of the 2-inch laterals are caps in which 1-inch holes have been drilled. The end of the manifold was plugged. The water entered from the right and flowed out of the 1-inch holes in the caps. The heights of the jets issuing from the holes in the caps indicated the quantities of water discharged from the various orifices. The heads on the orifices were indicated in 10 glass tubes which can be seen in figure 1.

FORMULA FOR PRESSURE ON A SLOT IN A PIPE

It is convenient to consider first the variation of pressure in a pipe with a long, narrow slot and to neglect pipe friction. Consider a straight pipe with a uniform cross-sectional area of A square feet, having a slot e feet wide and L feet long parallel to the axis of the pipe, as illustrated in figure 3. Assume the pressure on the slot to vary from h of water at one end to H feet of water at the other end and the pressure at any point x feet from the beginning of the slot

[1] Presented before the Illinois Section meeting, March 30, 1928.

[2] Professor of Mechanics and Hydraulics, University of Illinois, Urbana, Ill.

[3] Graduate Student, University of Illinois, Urbana, Ill.

[4] Journal, December, 1927, page 664.

to be y feet of water. At any section of the pipe x feet from the beginning of the slot the mass of water passing in dt seconds will be

$$\frac{w\ v\ A}{g}\ dt$$

where w is the weight of one cubic foot of water (62.5 pounds), v is the velocity in the pipe at that section, in feet per second, and g is the acceleration of gravity (32.2 feet per second per section). At a

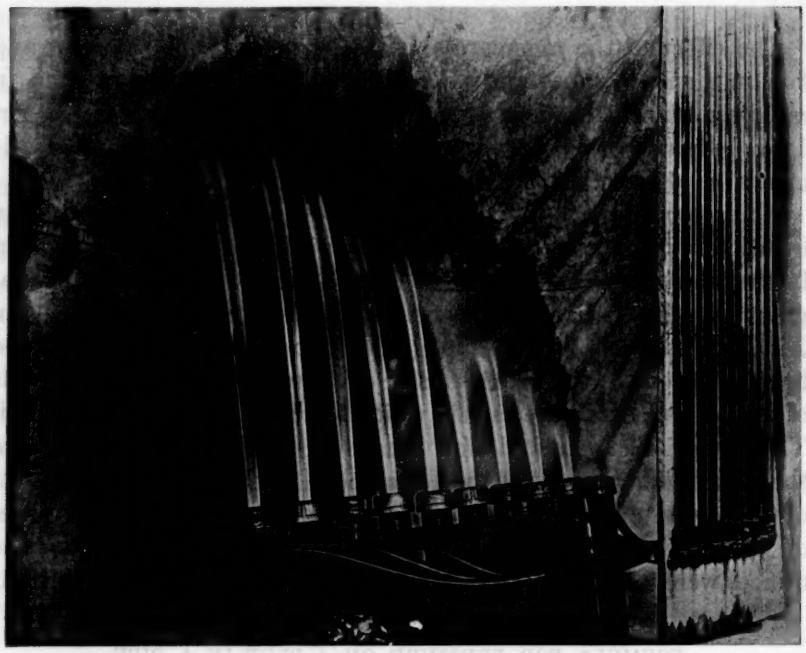


FIG. 1

section dx feet further along the pipe the velocity in the pipe is $v - dv$ feet per second and the pressure has increased to $y + dy$ feet of water. From the principles of impulse and momentum:

$$[w\ A\ (y + dy) - w\ A\ y]\ dt = \frac{wv\ A}{g}\ dt\ [(v - dv) - v]$$

hence

$$dy = -\frac{v}{g}\ dv \tag{1}$$

$$\int dy = -\frac{1}{g}\int v\ dv$$

$$y = -\frac{v^2}{2\ g} + C$$

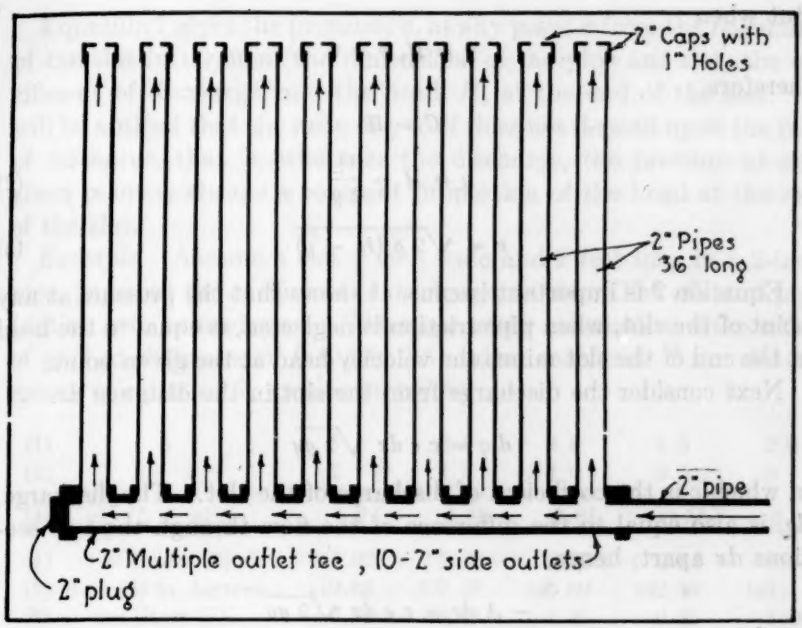

2" Caps with
1" Holes
2" Pipes
36" long
2" pipe
2" Multiple outlet tee , 10-2" side outlets
2" plug

FIG. 2

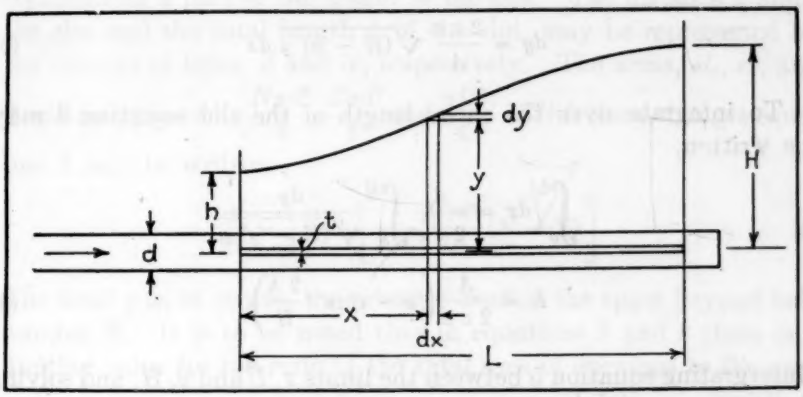

dy
y
H
h
t
d
x
dx
L

FIG. 3

But when

$$y = H,\ v = 0$$

therefore

$$C = H$$

$$y = H - \frac{v^2}{2g} \tag{2}$$

$$v = \sqrt{2g(H - y)} \tag{3}$$

Equation 2 is important because it shows that the pressure at any point of the slot, when pipe friction is neglected, is equal to the head at the end of the slot minus the velocity head at the given point.

Next consider the discharge from the slot in the distance dx.

$$dq = c\,e\,dx\sqrt{2gy}$$

in which c is the coefficient of discharge of the slot. The discharge, dq, is also equal to the difference of the flow through the two sections dx apart, hence,

$$-A\,dv = c\,e\,dx\sqrt{2gy}$$

$$dv = -\frac{c\,e\sqrt{2gy}}{A}\,dx \tag{4}$$

Substituting the value of v from equation 2 in equation 1, and eliminating dv from equation 3.

$$dy = \frac{2\,c\,e}{A}\sqrt{(H - y)\,y}\,dx \tag{5}$$

To integrate over the entire length of the slot equation 4 may be written,

$$\int_o^L dx = \frac{A}{2\,c\,e}\int_h^H \frac{dy}{\sqrt{(H - y)\,y}}$$

$$L = \frac{A}{2\,c\,e}\left(\pi - \text{vers}^{-1}\frac{2h}{H}\right) \tag{6}$$

Intergrating equation 5 between the limits x, L and y, H, and solving for y.

$$y = \frac{H}{2}\,\text{vers}\left[\pi - \frac{2\,c\,e}{A}(L - x)\right] \tag{7}$$

Equation 7 gives the pressure, y, at any point x from the beginning of the slot in terms of the dimensions of the pipe and slot, the coefficient of discharge, and the head, H, at the end of the slot. It will be noticed that the ratio of y to H does not depend upon the rate of discharge, that is, whatever the discharge, the pressure at any given point is always a constant proportion of the head at the end of the slot.

Example. Assume a slot $\frac{1}{8}$ inch wide and 2 feet long in a 2-inch pipe, and that the coefficient of discharge is 0.64. The effect of pipe friction is to be neglected. The steps in the calculation of the ratios of y/H at distances of 0.4, 1.0, 1.5 and at each end of the slot by means of equation 7, are shown below.

(1)	x	0	0.5	1.0	1.5	2.0
(2)	$L - x$	2	1.5	1.0	0.5	0
(3)	$\frac{2ce}{A}(L - x)$	1.22	0.92	0.61	0.31	0
(4)	π − row (3)	1.92	2.23	2.53	2.84	3.14
(5)	Row (4) in degrees	110.05	127.58	145.00	162.48	180
(6)	cos [Row (5)]	−0.34	−0.61	−0.82	−0.95	−1.00
(7)	vers = 1 − cos	1.34	1.61	1.82	1.95	2.00
(8)	y/H	0.67	0.80	0.91	0.98	1.00

The formulas found for the case of a slot in a pipe may be modified to apply to a series of holes in a pipe. Each hole may be taken as representing a part of the length of the slot. The distance x along the slot and the total length L of the slot, may be represented by the number of holes, Z and N, respectively. The areas, eL, ex, and A will be replaced by $\frac{N\pi d^2}{4}$, $\frac{Z\pi d^2}{4}$ and $\frac{\pi D^2}{4}$. With these changes equation 7 may be written

$$\frac{y}{H} = \frac{1}{2}\,\text{vers}\left[\pi - \frac{2\,cd^2}{D^2}(N - Z)\right] \tag{8}$$

The head y is, of course, the pressure head in the space beyond hole number Z. It is to be noted that in equations 7 and 8 there is a limiting value for the ratio of the total area of openings to the area of the cross section of the pipe. The value of $\frac{2ceL}{A}$ and $\frac{2cd^2N}{D^2}$ in equations 7 and 8, respectively, cannot exceed π because the versed sine, and hence the pressure head, y, would be zero. This means that, if the total area of the slot or the holes exceeds the limiting

value, there will be no flow from some of the slot or holes. It will be noticed in figure 1 that there is almost no flow from the first orifice at the right.

The effect of pipe friction on the pressures and discharges may be taken into account by a process of approximation, as follows: Assume a pressure head, H, at the closed end of the manifold (or perforated pipe). The discharge through the last opening may then be determined approximately by the formula,

$$q_1 = c\,a\,\sqrt{2\,g\,H}$$

in which a is area of the opening in square feet, c is the coefficient of discharge. The velocity in the pipe approaching the opening is

$$v_1 = \frac{q_1}{A}$$

in which A is the area of the cross-section of the pipe in square feet.

The first approximation of the pressure in the pipe on the side from which the water approaches the opening is, from equation 2,

$$y_1 = H - \frac{v_1^2}{2\,g}$$

The approximate average pressure on the opening is therefore

$$\frac{H + y_1}{2}$$

The velocity in the pipe approaching the opening is then recalculated

$$v_2 = \frac{q_2}{A} = \frac{c\,a\,\sqrt{2\,g\,\dfrac{H + y_1}{2}}}{A}$$

and the pressure is

$$y_2 = H - \frac{v_2^2}{2\,g}$$

It is rarely necessary to make more than the first approximation, because the difference of pressure on the two sides of the hole is usually

very small unless the total area of the holes is large as compared with area of cross-section of pipe.

TABLE 1

OBSERVED VALUES			CALCULATED
y	$\frac{v^2}{2g}$	c	$c = 0.745\,\frac{y - \frac{v^2}{2g}}{y}$
3.22	0.258	0.685	0.685
3.24	0.224	0.69	0.693
3.26	0.186	0.70	0.702
3.28	0.151	0.71	0.710
3.30	0.120	0.715	0.717
3.32	0.093	0.725	0.725
3.33	0.068	0.73	0.730
3.34	0.047	0.735	0.735
3.36	0.029	0.74	0.738
3.37	0.016	0.74	0.742
3.38	0.007	0.745	0.744
3.38	0.002	0.68	0.745

TABLE 2

HOLE NUMBER	y OBSERVED	DISCHARGE q	VELOCITY IN PIPE	$\frac{v^2}{2g}$	h_f	Σh_f	y CALCULATED
		cubic feet per second	*feet per second*	*feet*	*feet*	*feet*	*feet*
Cap	3.38		0.00	0.00	0.00	0.00	3.38
12	3.38	0.00768	0.33	0.002	0.000	0.000	3.38
11	3.38	0.00841	0.65	0.007	0.001	0.001	3.37
10	3.37	0.00835	1.02	0.016	0.002	0.003	3.37
9	3.36	0.00833	1.37	0.029	0.003	0.006	3.36
8	3.34	0.00825	1.73	0.047	0.005	0.011	3.33
7	3.33	0.00819	2.09	0.068	0.007	0.018	3.33
6	3.32	0.00811	2.44	0.093	0.009	0.027	3.32
5	3.30	0.00797	2.78	0.120	0.012	0.039	3.30
4	3.28	0.00789	3.12	0.151	0.015	0.054	3.28
3	3.26	0.00776	3.46	0.186	0.018	0.072	3.27
2	3.24	0.00762	3.79	0.224	0.020	0.092	3.25
1	3.22	0.00755	4.07	0.258		0.092	3.21

The friction due to the flow between the next to the last and the last opening is found from tables or diagramas.

The head just beyond the next to the last hole is then

$$y_2 - h_f$$

The process of approximation is then repeated for the next to the last opening using the head $y_2 - h_f$ instead of H, and so on for the remaining openings. The pressures in the pipe and the discharge from each opening so found are for the condition that the pressure at the end is H foot. For any other pressure H_1 at the end of the pipe the pressure at any point in the pipe may be found by multiplying the calculated pressure by H_1/H. The discharge from any opening may be found by multiplying the calculated discharge by $\sqrt{H_1/H}$

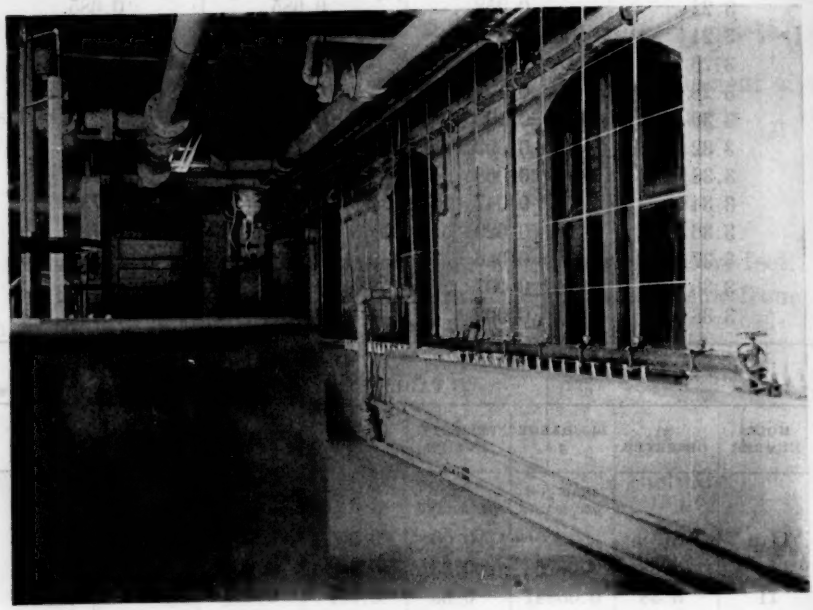


FIG. 4

The coefficient of discharge of the openings in a pipe depends upon the velocity of flow in the pipe. The coefficient decreases as the velocity in the pipe increases in accordance with the empirical formula

$$c = \frac{y - \frac{v^2}{2g}}{y} c_e$$

in which c = coefficient of discharge on any opening.
c_e = coefficient of discharge of the last opening.
y = head on the opening.
$v^2/2g$ = velocity head of water in the pipe approaching the opening.

The coefficient of discharge of ten $\frac{3}{8}$-inch openings in a 2-inch pipe found by experiment compared with the coefficient calculated from the above equation is shown in table 1.

The arrangement of the apparatus is shown in figure 4. The holes were drilled and reamed and were spaced 6 inches center to center. They were sharp edged and all burrs were removed. The last hole gave erratic results probably due to an obstruction. In using the formula it was assumed that the coefficient of the last hole was 0.745. The formula is empirical but fits the results of the experiments remarkably well.

The results of one set of experiments made on the perforated pipe shown in figure 4 compared with the calculated values are shown in table 2. The values of the friction loss was determined experimentally from experiments on a 2-inch pipe of the same kind as the perforated length. The calculated value of y was found from the equation

$$y = 3.38 - \left(\frac{v^2}{2g} - \Sigma h_f\right)$$

It will be noted that the agreement between the calculated values of the pressures and those determined experimentally agree very closely.

REPORT OF COMMITTEE NO. 1 ON STANDARD METHODS OF WATER ANALYSIS[1]

The activities of Committee No. 1 on Standard Methods of Water Analysis this year have followed in a general way the plans outlined in the preceding report and have also included a few preliminary studies on subjects which came up for attention during the year. The personnel remains the same as last year with the exception of the addition of Mr. Linn H. Enslow, of New York, and Mr. Sheppard T. Powell, of Baltimore, as additional field representatives.

A statement of the assignments and progress of work under the various referees follows:

BACTERIOLOGICAL METHODS

The Composition of Brilliant Green Lactose Bile Medium and Other Media Studies, Mr. H. G. Dunham, Referee

The amount of work done on the brilliant green bile medium during the current year has been very much reduced. Such investigations as have been made have concerned the use of 2 per cent bile with 1:75,000 brilliant green in comparison with 5 per cent bile containing 1:10,000 brilliant green. The general opinion seems to be that the more dilute medium is desirable.

Additional work was done this year on the new "Agar-Dye Differential Medium for the Colon Typhoid-Group" as described by A. J. Salle, of California, with the idea of ascertaining its value in the bacteriological examination of water. The early work was not very encouraging, and it was thought that the trouble was that the proper dyes were not employed. Comparisons of the medium were made with the "Standard Methods, American Public Health Association and American Water Works Association" medium, and the Levine Eosine Methylene Blue Agar, included in the Standard Methods of 1925. Samples of the dyes and basic medium used in his original work were very kindly supplied by Salle and these dyes were used in the preparation of media for comparison with media

[1] Presented before the San Francisco Convention, June 11, 1928, and approved by The Committee on Water Works Practice.

made up by the referee from material available to him. Various combinations of Salle's materials and others were tried. Results were disappointing in that the experimenters were unable to see that any better differentiation was obtained than could be obtained on Levine's medium. In conclusion, it may be said that the new Salle medium, as described in the *Journal of Infectious Diseases*, volume 41, page 1, (1927) does not appear to be appreciably better than the Levine Eosine Methylene Blue Agar, when the latter medium is prepared in accordance with the "Standard Methods" formula and the proper dyes are employed in the right concentration.

A preliminary study has recently been begun on the "Cyanide Citrate Pour Plate Method for Direct Determination of the Colon-Aerogenes Content of Water and Sewage" as described by Ralph E. Noble in the JOURNAL OF THE AMERICAN WATER WORKS ASSOCIATION, Vol. 19, page 182, (1928). Considerable correspondence regarding the medium has been carried out from the office of the chairman of the committee in an effort to learn the experience of various individuals who have tried out this modification of the Ayres-Rupp medium. The general criticism that the procedure is too complicated for general use, especially in the smaller water works laboratories, has been answered in part by an attempt on the part of Noble to simplify the procedure. Further investigation will be given to the medium to see if it merits a general trial in its present state or whether it will be better to await further developments before such a study is considered. It is desirable to have a plate method for the determination of the organisms of the colon group, since such a method would, theoretically at least, make the enumeration of the organisms more easy and more accurate than the present fermentation methods. It should, however, be such that it might be used by persons of no great training in bacteriology and for that reason should require very simple procedures and should not involve the careful separation of the organisms by their appearance. Presence of gas in fermentation tubes is more easily recognized even by the most inexperienced workers.

In this connection it may be well to caution experimenters against the procedure frequently followed of comparing the extreme period necessary with doubtful cases of confirmation of colon group organisms by the existing standard procedures with the ideal cases using their own newly developed media. In doubtful cases it will be necessary to confirm the organisms by procedures equally as long as the

standard ones. Thus the claim for greater speed is often nullified. The practice of many laboratories of holding fermentation tubes for the forty-eight-hour period before examining them for gas production is strongly to be condemned. The tubes should be examined at least twice in each twenty-four-hour period and upon the appearance of any gas the material should be taken for the beginning of confirmatory tests. The present Standard Methods of Water Analysis, American Public Health Association and American Water Works Association, 1925, require examination at least once in each twenty-four-hour period and call attention to the fact that it is desirable to make transfers to Endo or eosine methylene blue agar as soon as possible after gas formation has occurred.

Such a procedure as outlined frequently gives a sufficient degree of certainty in thirty-six hours and occasionally less time. Fermentation in brilliant green lactose peptone bile (see Mr. Jordan's report below) when run in parallel with lactose broth may give sufficient information within twenty-four hours.

Non-Confirming Spore Formers and Their Significance in Water Examination, Mr. Norman J. Howard and Dr. John F. Norton, Joint Referees

It has been determined that the anaerobic spore formers may interfere with the tests for the colon group and an attempt is being made to determine whether or not the aerobic spore formers ever outgrow the coliform organisms to such an extent that the coli will be entirely missed. This work is in incomplete form.

The Use of Brilliant Green Lactose Peptone Bile and Other Tri-Phenyl Methane Dyes as Secondary Fermentation Media in the Determination of the Bacterium Coli Group, Mr. Harry E. Jordan, Referee

The report covering the work of Mr. Jordan and his associates was published in the JOURNAL OF THE AMERICAN WATER WORKS ASSOCIATION, vol. 18, no. 3, page 337 (1927). As a result of this work Mr. Jordan recommends the following procedure as an optional approved procedure for the organisms of the colon group:

A. I. *For unfinished waters* (raw, settled and filtered).

1. Plant in parallel, five tubes of lactose broth (L.B.) and five tubes of brilliant green lactose peptone bile (B.G.B.) in proper dilutions.

2. Tubes should be racked alternately as L.B., B.G.B., L.B., B.G.B., etc., and each pair treated as a unit.

II. If gas is produced in twenty-four hours in both broths the result is recorded as "Partially Confirmed" and may be known as Group 1. No further planting is necessary.

III. If gas is produced in both broths in forty-eight hours the result is recorded as "Double Presumptive" and may be known as Group 2. No further planting is necessary.

IV. If gas is produced only in the lactose broth the result may be recorded as "Presumptive" and known as Group 3. Further planting into B.G.B. is necessary. If the bile tube ferments, the result is recorded as positive colon group. If there is no production of gas in B.G.B. the result is recorded as negative colon group.

B. I. *For finished waters* (plant effluent, tap and wells). Original planting made and recorded as above except:

1. When both broths ferment, subcultures are made from the bile tube. Completion is carried on as prescribed by Standard Methods of Water Analysis, American Public Health Association and American Water Works Association, 1925.

2. When only the lactose broth ferments, subcultures are made from the original lactose broth to B.G.B. If the bile tube ferments, further completion is carried on as prescribed by Standard Methods, except that the secondary fermentation planting is made into lactose broth and B.G.B. Completion should not be recorded unless the bile tube ferments.

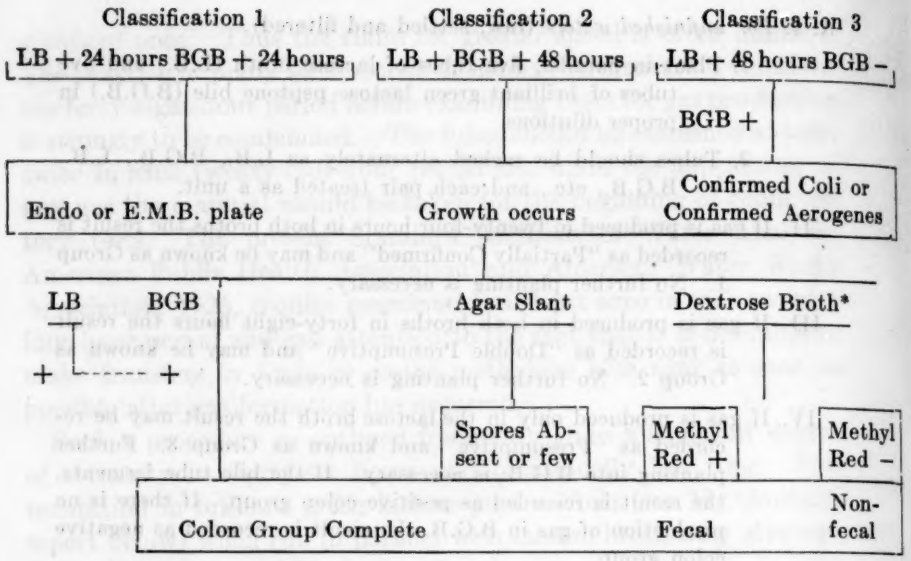
Colon group isolation for finished waters

All planting in parallel in Lactose Broth and Brilliant Green Bile, Fermenting Cultures classified as follows:

Lactose Broth +, Brilliant Green Bile + (both in twenty-four hours).
Classification 1—"Partially Confirmed."

Lactose Broth +, Brilliant Green Bile + (both in forty-eight hours).
Classification 2—"Double Presumptive."

Lactose Broth +, Brilliant Green Bile − (in forty-eight hours).
Classification 3—Presumptive.



* One or more of the differential tests given on page 111, Standard Methods of Water Examination, American Public Health Association and American Water Works Association may be substituted for the methyl red test.

Note: In this connection, and at the suggestion of Dr. Levine, the chairman of the committee would recommend that the Voges-Proskauer test be substituted for the Methyl Red Test for the following reasons: (1) less time may be required; (2) a definite substance, acetyl methyl carbinol is being tested for, rather than a certain hydrogen ion concentration, and (3) the formation of the required hydrogen ion concentration may be due to other organisms acting alone or in symbiosis.

The terms "partially confirmed" and "double presumptive" are somewhat confusing and should be replaced by more accurately descriptive terms, if such can be devised.

The Use of Eosine Methylene Blue Agar and Modifications in the Confirmation of Organisms of the Colon Group, Dr. Max Levine, Referee

Dr. Levine's time has been very fully occupied during the current year in connection with stream pollution investigations and the disposal of certain industrial wastes. He has therefore been delayed in the starting of work on his assignment.

The Use of Brilliant Green Lactose Peptone Bile as a Primary Medium in the Detection of Organisms of the Colon Group, Mr. MacHarvey McCrady, Referee

Mr. McCrady was unable to do any work in connection with the activities of Committee No. 1 during the year because of the demands made upon the Quebec Provincial Bureau of Health during the typhoid epidemic in Montreal last year.

CHEMICAL AND PHYSICAL METHODS

The Determination of Turbidity and Coefficient of Settling, Mr. John R. Baylis, Referee

In addition to his work on turbidity measurements, Mr. Baylis has been required in the course of his regular work to devote a considerable portion of his time to the work on the detection of minute amounts of phenols in water. In this latter work he has kept in touch with the referee of the committee on phenols, Professor C. S. Boruff.

Considerable work has been done on developing a more accurate measure of the suspended matter in water that has been coagulated. Years of experience in trying to apply present methods of turbidity measurements to coagulated water in filtration work convinces the referee that such methods leave much to be desired. Considering the fact that we are concerned primarily with the volume of the coagulated matter it seems to the referee that a volume measurement would come nearer giving the desired information.

Much time has been given to working out a procedure for making accurate volume measurements. This is now being done by centrifuging the water in a 100 cc. Goetz tube. The centrifuge precipitates the coagulated matter into a small calibrated arm at the bottom of the tube. The procedure for making this test, together with a description of the equipment used, is given in a supplementary report to the Chairman of Committee No. 1 before the San Francisco meeting. This method has been adopted for measuring the coagulated matter at the Chicago experimental filtration plant.

Phenol Determinations

Considerable time has been given to methods for making phenol determinations. This is not a part of the work assigned to Mr. Baylis, but it became necessary in order to obtain accurate informa-

tion on the amount of phenol in the Lake Michigan water at Chicago. The Fox and Gauge method has been improved, and a method for using 2,6-dibromoquinonechloroimide has been worked out. The latter method is specific for phenols in that the color developed is dependent on the formation of an indophenol. It is believed that it will detect most phenols likely to be found in public water supplies. A method has been worked out whereby 1 part per billion of phenol can be determined. This is well below the amount that will give a chlorophenol taste when chlorine is added. The work on the Fox and Gauge method has already been reported to Professor C. S. Boruff, the referee on phenol determinations, and the method for using 2,6-dibromoquinonechloroimide will be reported to him as soon as time is available for writing it up.

The Mineral Analysis of Water, Mr. R. C. Bardwell, Referee

Correspondence developed the fact that a number of water analysts consider that it would be unwise to include methods of examination in terms of grains per U. S. gallon among the methods using the part per million unit recognized in Standard Methods of Water Analysis, American Public Health Association and American Water Works Association, 1925. It was also felt that it would be unwise to give apparent official sanction to any method of reporting hypothetical combinations of the ions. Some opposition was also met with regard to the plan of setting up two different standard soap solutions.

With these facts in mind the referee will rewrite the material appearing in the August, 1925, issue of the JOURNAL OF THE AMERICAN WATER WORKS ASSOCIATION which described the proposed standard methods of rapid examination of boiler water, including in foot-notes in the revision both the directions for conversion to grains per gallon and the scheme proposed for the calculation of the hypothetical combinations which are preferred by non-technical water users in many cases. It is planned to ask Mr. Bardwell to make a study of various soap solutions for the determination of hardness by the soap method. The chairman of the committee plans to make an inquiry into the procedures and solutions which have been suggested in the literature. A large number of variations of procedure and types of solutions are known to exist.

Mr. Bardwell, the referee, has continued to act as a liason agent with the Joint Committee on Boiler Feed Water Studies under the chairmanship of S. T. Powell. At the present time Mr. Powell

is also a field representative of Committee No. 1 and the chairman of Committee No. 1 is also a member of Sub-Committee No. 8 of the Boiler Feed Waters Studies Committee. Sub-Committee No. 8, under the chairmanship of Harold Farmer, of the Philadelphia Electric Company, is entrusted with the study of analytical methods and has concerned itself chiefly with the estimation of the amount of dissolved oxygen in boiler waters by a modification of the Winkler method. Investigations of sampling methods have also been conducted.

The Detection of Phenols, Professor C. S. Boruff, Referee

During the past year there has been considerable knowledge contributed on the subject of the determination of small amounts of phenols in waters. Mr. John R. Baylis, has presented important material in the JOURNAL OF THE AMERICAN WATER WORKS ASSOCIATION, vol. 19, page 597–604 (May, 1928). Mr. J. H. Feigel has published in the *Bulletin of the Engineering Society of Buffalo*, vol. 8, 11 (February, 1928) an article on "Phenol Wastes and Their Treatment to Secure Freedom from Taste." Mr. F. W. Sperr, Jr., as chairman of an investigating committee, has published in the JOURNAL OF THE AMERICAN WATER WORKS ASSOCIATION, vol. 19, 605 (May, 1928) an article entitled "Test for Phenolic Tastes and Odors in Water After Chlorination." This last article may also be found in substance in the *News Edition of Industrial and Engineering Chemistry*, vol. 6, 16 (March, 1928), and in *United States Public Health Reports*, vol. 43, 881–2 (April 13, 1928).

It seems to be quite generally conceded that as little as 5 parts per billion of phenols in chlorinated water may cause tastes and odors. As in other taste and odor problems there are many contributing factors. Hence the minimum concentration of phenols that may cause tastes and odors on chlorination may vary greatly from place to place.

The referee, through assistants, has continued his studies on the Fox and Gauge method of determination, but as reported before and as reported by Baylis the test is very exacting as to technique and can not be used in certain waters with a suitable degree of accuracy and certainty, especially if the phenolic content is near the limit of reagent sensitivity. Furthermore organic chemistry tells us that diazo reactions are not reliable in high dilutions. It is possible for a diazonium reagent to hydrolyze and thus actually produce a phenol.

Baylis reports an accurate quantitative method using Gibbs' 2,6-dibromoquinonchloroimide as the main reagent. Baylis reports it possible to detect 1 p.p.b. of phenol by this method. For the discussion of the method the original paper should be consulted. The referee has not yet tried out the method. Baylis uses a standard phenol solution to run with his determinations. This is a desirable practice in some cases, but for routine laboratory determinations it would be better if permanent color standards could be prepared. This, however, can be worked out in time if the method proves sufficiently valuable.

In his phenol-recovery studies Baylis states that he has been able to collect about 75 per cent of the original phenolic content of a

TABLE 1

SUBSTANCE	NUMBER OF RUNS	QUANTITY OF SUBSTANCE	AVERAGE RECOVERED WHEN 50 PER CENT DISTILLED OVER	AVERAGE RECOVERED WHEN 60 PER CENT DISTILLED OVER
		p.p.m.	*per cent*	*per cent*
Phenol (Baylis)		0.02	75	
Phenol	5	0.03	78	
Phenol	3	0.06	59	
o-Cresol	3	0.06	45	52
m-Cresol	4	0.06	57	61
p-Cresol	2	0.06	18	20
Mixture*	1	0.06	59	64
Mixture†	1	0.06	71	

* Equal parts of the three cresols.

† One part each of three cresols and one part phenol.

sample when 400 ml. of the original 800 ml. are collected as a distillate, or about 85 per cent if 500 ml. are collected. He used a solution containing 20 p.p.b. (0.02 p.p.m.) of phenol. The referee has worked on recovery using phenol, the three cresols and mixtures of the cresols alone and with phenol. The more reliable determinations are summarized in table 1. In all cases 500 ml. of the original was placed in an all glass ammonia still and the solution made acid with H_2SO_4. The distillate was collected in 50 ml. Nessler tubes in which the test was completed for the phenolic content. The Fox and Gauge test was used in all the determinations using KOH as the added alkali. With p-cresols the reagent is unreliable which

probably accounts for the low per cent recovery of this compound as measured by the reagent. Baylis notes that the Gibbs reagent is also unreliable when used to determine p-cresol.

The taste and odor method as reported by F. W. Sperr, Jr. (Journal of the American Water Works Assoc., vol. 19, 605, 1928) has not yet been investigated by the referee. There are a number of workers who prefer a direct taste and odor method, but the majority do not desire to rely on the differential variations in the sensitivity of the taste buds as a quantitative method.

In the determination of phenols errors due to contamination have been the outstanding obstacle that the referee and his assistants have had to face in making and checking phenol distillations. Ever since the work was started at Monmouth there has been trouble with contamination. This probably has influenced the results in other places, in many cases probably without the knowledge of the investigator. The following instances have been noted a number of times and may serve to illustrate the possibilities of error in quantitative work.

1. A number of phenolic solutions of about 0.02 p.p.m. were distilled through a regular Liebig condenser outfit with rubber connections and then the apparatus cleaned merely by washing a number of times with distilled water. Distilled water was then placed in the flask and distilled. The first 50 cc. of distillate was found to contain about 0.02 p.p.m. of phenol. The distilled water used was tested before being placed in the distilling flask and proved to be phenol free. Hence the phenol must have come from the stoppers and glassware. A Maharg's all glass still with mercury seal also retained phenol, but did not show as large an amount on subsequent use as did the stills with rubber and cork connections.

2. A number of phenol tests on solutions containing about 0.1 p.p.m. were made in a Nessler tube and the tube then treated with cleaning solution, hot distilled water and rinsed with distilled water. If this tube were filled with phenol-free distilled water and the phenol reagents added, it was found to give a test showing about 0.03 p.p.m. of phenol.

3. Rubber stoppers and tubing, cocks, the hands and the like were found to collect phenols or substances able to bring about reactions to give colors with the reagents used. Nothing should come in contact with the solutions or reagents except clean glassware. Glass adsorbs less phenol than other things and is more easily cleaned.

Test solutions must be mixed with clean stirring rods, and not shaken or mixed by tilting. All reagents must be kept in glass stoppered bottles and blanks run from time to time to see that they function as they should.

Mr. Kenneth Irey, research student under the referee at Monmouth College, has worked out a method of cleaning glassware of adsorbed phenols. He has found that if the glassware is washed thoroughly with benzene which in turn is followed by ethyl alcohol and then by distilled water, the phenols are removed. The phenolic products dissolve in the benzene which is then drawn off. The small amount of benzene left on the glass is dissolved by the alcohol which in turn is removed by the water. In cleaning a distilling apparatus the benzene is distilled through the entire outfit, as also is the alcohol. No phenol remains. In cases of heavy contamination, cleaning solution is used before the benzene treatment. Absolute blanks will be given if previously contaminated glassware is cleaned in this manner.

Samples should be collected in clean glass stoppered bottles and determinations made as soon as possible for the concentrations if below 10 p.p.m. will be gradually decreased due to bacterial action and other complex reactions.

Investigations in the laboratory of the Chairman of Committee No. 1 have shown that the precautions indicated above are necessary to remove traces of phenols from the apparatus and that they are effective.

The Determination of Free Chlorine, Dr. A. M. Buswell, Referee

A report of further studies on the orthotolidine method of determining free chlorine in waters has been submitted to Dr. Buswell by Professor C. S. Boruff, who did graduate work on this subject under Dr. Buswell at the University of Illinois. This report has not yet come into the chairman's hands accompanied by Dr. Buswell's comments.

Mr. Linn H. Enslow, one of the field representatives of Committee No. 1, has called attention to the fact that the acid starch-iodine methods at times gives results many times higher than with the neutral starch-iodide or the orthotolidine methods, and that frequently the neutral starch-iodide method produces results higher than obtained by the orthotolidine method. The question arises as to what test is the most dependable to indicate efficient chlorination and

chlorination control. In sewage work the residual chlorine as indicated by the starch methods appears to require a relatively longer period of time to disinfect sewage effectively, whereas the amount indicated by orthotolidine is rapidly efficient and seems to be almost immediately so in cases where 0.5 p.p.m. residual chlorine is indicated. An important point to be considered concerns the chlorine combination which does not react with orthotolidine but does react with the starch-iodide reagents. How important are nitrites and similar compounds, or chlorates and manganese salts?

The Determination of Iodine in Water, Mr. Dale L. Maffitt, Referee

The work on iodine determination during the last year has, for the most part, been the testing of the methods as outlined in our report of last year. The referee has been making routine-determinations of the iodine in the Des Moines water supply according to this procedure in order to try the method, as well as to collect the data obtained from the results of the determinations.

The referee has also collected some data on the amount of iodine passing over during the ignition in the ignition tube with the idea in mind of eliminating this part of the procedure if practical.

During the coming year it is hoped to get into communication with other laboratories where this method may be tried in order to learn how successful they may find it and in order to profit by any ideas or changes that may be suggested.

The Determination of Biochemical Oxygen Demand, Dr. F. W. Mohlman, Referee

Work is under way in several laboratories on the standardization of the technique for the biochemical oxygen demand determination. Emery J. Theriault's outstanding contribution is presented in Public Health Bulletin No. 173 of the United States Public Health Service issued in 1927 on "The Oxygen Demand of Polluted Waters." This is a monograph of 185 pages which covers completely the historical development and significance of the test.

The work of the laboratory of the Sanitary District of Chicago is described in a paper on "The Technique and Significance of the Biochemical Oxygen Demand Determination" by F. W. Mohlman, G. P. Edwards and Gladys Swope, published in *Industrial and Engineering Chemistry*, vol., 20, no. 3, 242–246. (1928).

Dr. Willem Rudolfs has done some work on the use of buffered

solutions as dilution water. Sodium bicarbonate water is now being used in a number of laboratories. Further work is to be done during the next few months on comparisons of several varieties of synthetic dilution waters. Suggestions concerning the composition of such waters, and offers of coöperation in the proposed analytical investigations will be gratefully received by the referee.

Mr. Linn H. Enslow, field representative of the committee, has suggested the study of the chlorine demand test in comparison with the biochemical oxygen demand. This test for chlorine consumption is not new. It has been studied by Wolman and Enslow in Maryland, (Jour. Indust. Eng. Chem., vol. 11, 209, March 1919) and more recently by Jacob R. Meadow and Harrison Hale of the University of Arkansas (Jour. Amer. Water Works Assoc., vol. 18, no. 1, 75–81, July, 1927) in connection with an attempted comparison with the old consumed oxygen test. In Germany, Bach and Glaeser suggest the "chlorine number," i.e. chlorine demand, of sewage effluents or polluted waters as a more valuable index of strength than the permanganate oxygen consumption test. These men suggest the sodium salt of paratoluene sulphochloramide, or "activin" in view of its greater stability as a laboratory reagent than the chlorine water or hypochlorite solution. If the chlorine demand is studied to see if there is a reasonably close correspondence between this determination and that for biochemical oxygen demand, the chlorine absorption test will itself require to be studied to establish a satisfactory procedure. The object sought in attempting to establish such a correlation is, of course, a shortening of time for the test.

MICROSCOPICAL METHODS

Microscopical Examination of Water (Plankton), Mr. W. F. Langelier, Referee

The referee has had made two wire cloth nets, 350 meshes to the inch, with which he proposes to experiment in connection with the use of the net method for the collection of plankton organisms as originally developed by Hensen. Both the Sedgwick-Rafter method, now the official method of Standard Methods of Water Analysis, American Public Health Association and American Water Works Association, 1925, and the net method suffer from the fact that the nannoplankton, or the smallest of the organisms superior to the bacteria, almost entirely escape detection by either method. The im-

portance of the nannoplankton in water supply matters is therefore practically unknown. The two methods for the determination of the plankton organisms are only roughly quantitative in the opinion of the referee, but he believes that both should be studied in an attempt to adapt them to the needs of the water works operator in a more satisfactory manner than they present at this time.

The Field Representatives, Mr. Lewis I. Birdsall, Mr. Linn H. Enslow, and Mr. Sheppard T. Powell

During the year Mr. Birdsall has called the chairman's attention to a number of matters, such as the conference on phenol tastes which was held in Pittsburgh on February 6 under the chairmanship of F. W. Sperr, Jr., of the Mellon Institute, and the paper by W. D. Collins, on the methods used by the United States Geological Survey for mineral water analysis, published as Water Supply Paper No. 596-H.

Mr. Enslow has suggested the comparison of various methods of testing waters for residual chlorine and the comparison of chlorine demand and biochemical oxygen demand which have already been referred to in the above paragraphs. He has also written about such other matters as the current status of chloramines in water purification.

Mr. Powell has enabled the chairman to keep fully in touch with the activities of the Joint Committee on Boiler Feed Water Studies.

THE WORK OF THE OFFICE OF THE CHAIRMAN

The work conducted by the office of the Chairman of Committee No. 1 has included the usual extensive correspondence. In addition to this work the Chairman has carried on the experiments on the use of brilliant green lactose peptone bile which have proved so successful in the routine work on Iowa waters. In connection with the poisoning of cattle by cyanide waste in a small Iowa stream which has been described by A. H. Wieters, State Sanitary Engineer of Iowa, in *Water Works Engineering*, vol. 81, page 204 (February 15, 1928) it was desired to examine sewage and wastes for minute amounts of cyanides or hydrocyanic acid. In the waste which caused the trouble the concentration of the cyanide was much greater than in the wastes later experimented upon. Mr. Samuel D. Poarch, analyst in the laboratory under the Chairman's supervision, made a survey of the literature on the subject and attempted to apply several

of the methods of examination which appeared in the literature on the subject. For the quantitative estimation of the cyanide ion in the concentrations desired, these methods were not very satisfactory. In view of the fact that no standard method for the determination was developed, the Chairman sent copies of a translation of the promising Lavialle and Varrenne method to a number of chemists who were interested. The method of Lavialle and Varrenne is a qualitative one, but one of the individuals, to whom a copy of the translation was sent has, with one of his assistants, worked out a quantitative method utilizing the same principles. The quantitative method will probably be published in the near future under the names of J. W. Ellms and Y. Habeshian. The procedure worked out by Ellms and Habeshian allows the detection of 0.000005 gram of the cyanide ion (CN) in a 100 cc. sample of the water when the final liquid is concentrated to 10 cc. in the course of the work. As small an amount of the cyanide ion as 0.000002 gram may be detected when the final conversion of the sulfocyanic ion with the ferric ion and the comparison of the color of the ferric sulfocyanate with standards. It is necessary to exclude ferric meconate from the test by dissolving the ferric sulfocyanate in ether in which the salt of meconic acid is not soluble. The disappearance of traces of cyanides in sewage and wastes deserves further study and will probably receive it.

RECOMMENDATIONS

Your Committee No. 1 would respectfully submit the following recommendations with regard to the continuance of its work along the general lines of endeavor already laid down for its guidance by the Standardization Council of the Association.

1. The studies of the methods of testing for the members of the colon group of bacteria should be continued along such lines as seem to show promise, with special attention to the use of brilliant green lactose peptone bile.

2. The study of such new media as the Salle medium and the Noble cyanide citrate pour plate medium should be given such preliminary study as seems advisable and that if justified these studies should be supplemented by others of a more searching nature.

3. The study of non-confirming spore forming lactose-fermenting organisms should be continued and their significance should be considered very carefully. The matters of symbiosis and antibiosis as

well as the matter of the overgrowths should receive attention in this connection.

4. Consideration should also be given to the matter of the methods of estimation of coliform organisms in water employing the Phelps B. coli index, as well as those methods suggested by McCrady, Stein, and others.

5. Close liason should be maintained with the Joint Committee on Boiler Feed Water Studies through coöperation with Sub-Committee No. 8, on the Analysis of Boiler Waters, under the chairmanship of Harold Farmer, of the Philadelphia Electric Company.

6. Additional work should be carried out on the tests for free chlorine by orthotolidine, starch-iodide and other procedures. One of the matters to be considered in this connection is the form of chlorine compounds which will react with the various reagents.

7. The determination of chlorine demand should receive some attention both as to its use in the examination of ordinary waters and in connection with a possible correlation with the determination of biochemical oxygen demand in sewages and trades wastes.

8. The work on the determination of turbidity and coefficient of settling should be continued with special reference to the turbidity range from 0.2 to 25 p.p.m. turbidity. The volumetric estimation of the suspended matter of water deserves study along the lines suggested by Mr. Baylis, the referee.

9. A standard method for settleable solids in sewage is desirable. A more desirable piece of apparatus than the Imhoff cone might be devised.

10. The study of the determination of iodine should be continued and an effort should be made to secure information as to the general suitability of the method proposed in the most recent report published by Committee No. 1 (Jour. Amer. Water Works Assoc. vol. 19, pp. 553–573 (1928)).

11. The work on the determination of biochemical oxygen demand should be continued with especial attention to the preparation of a standard dilution water and the specification of details of technique to avoid errors by less experienced operators.

12. The investigations on the determination of dissolved oxygen in water and sewage should be resumed. Intensive work on the determination of dissolved oxygen in boiler waters should be undertaken in coöperation with Mr. Farmer's Sub-Committee No. 8 on Boiler Water Analyses.

13. Investigations on the determination of free carbon dioxide should be resumed. Coöperation with Mr. Farmer's committee is desirable in this connection.

14. The study of methods for the detection of phenols should be continued.

15. The study of the detection of minute amounts of cyanides in waters and sewages should be studied further. Attention should be given to their significance and a study of the rate of disappearance of the substance in sewage should be made.

16. A study of the nitrogen factors in water and sewage along the lines laid down by Buswell and Neave should be undertaken.

17. A study should be made of the nitrites and nitrates in strong trades wastes in which both are present.

18. The proposed rapid mineral analyses when rewritten should be submitted to the Committee of the American Public Health Association for their reaction to the methods and looking forward to their inclusion in the seventh edition of Standard Methods of Water Examination.

19. The study of the net method of the enumeration of the plankton organisms should be continued, together with the attempt to develop a standard plankton net of the Hensen type. Consideration of a suitable method for the nannoplankton should be undertaken.

20. Subject to the approval of the Committee on Water Works Practice, Committee No. 1 should be authorized to include in its membership such additional referees from among the membership of the American Water Works Association as may be necessary to handle the problems enumerated and any others which may need attention during the time between the Convention in June 1928 and the summer of 1929.

Respectfully submitted,

R. C. Bardwell,
John R. Baylis,
Lewis I. Birdsall,
C. S. Boruff,
A. M. Buswell,
H. G. Dunham,
Linn H. Enslow,
Norman J. Howard,
Harry E. Jordan,
Wilfred F. Langelier,
Max Levine,
MacHarvey McCrady,
Dale L. Maffitt,
F. W. Mohlman,
John F. Norton,
Sheppard T. Powell,
Jack J. Hinman, Jr., *Chairman.*

OUR PROPOSED NEW CONSTITUTION

By Wm. W. Brush[1]

The Committee on the Revision of the Constitution has submitted its final draft of the new Constitution and By-laws.

The members of this Committee, and especially its chairman, Ross L. Dobbin, have devoted to this work much time and thought, and the Association is greatly indebted to them. As the general membership of the Association may not be familiar with the reasons for the revision of the Constitution, and the advantages that it is expected will accure to the Association by this revision, I desire to set forth the reasons why I believe that the new Constitution should be adopted at our coming convention at Toronto. Briefly these reasons are as follows:

1. The form and substance of the new Constitution have been approved as to legality by eminent counsel.

2. A separation has been made into a Constitution and By-laws, whereas at present we have no By-laws. We have previously included in our Constitution many items which are not of sufficient importance to be in a Constitution.

3. By providing a representative on the Board of Directors for each section, every part of the territory covered by the Association will have its representative and will take part in formulating and executing the policies of the Association.

4. A nominating committee to fill the offices of President and Treasurer is to be formed by the members of all the sections on the Board of Directors, making this nominating committee representative of all sections of the society membership.

5. Representation on the Board of Directors is given to the chairmen of the two principal committees of the Association, i.e., Water Works Practice, and Publication, so that these chairmen can take part in the deliberations of the Board of Directors.

6. Provision is made for additional conventions, or regional meetings, but such meetings are only to be held as found advisable. In

[1]President of The American Water Works Association; Chief Engineer, Department of Water Supply, Gas and Electricity, New York, N. Y.

general, they would be held when and as desired by the sections in any portion of the territory covered by the Association.

The new Constitution and By-laws, if adopted, will give the Association a truly democratic and representative form of government, will eliminate any foundation for a claim that the Association is dominated by any small group or section of the country, and will permit the Association to carry on its work more effectively. Constructive criticism of any part of the proposed Constitution or By-laws will be most welcome to the Committee and to the officers of the Association. It is hoped that all the members will carefully read the proposed Constitution and By-laws and be prepared to take action thereon at our June, 1929, convention.

PROPOSED CONSTITUTION OF THE AMERICAN WATER WORKS ASSOCIATION

ARTICLE I

Name

The name of this Association shall be "The American Water Works Association."

ARTICLE II

The object of this Association shall be the advancement of knowledge of the design, construction, operation and management of water works, and its membership shall consist of persons interested in such matters, having such qualifications and classfications as shall be from time to time prescribed in the By-Laws.

ARTICLE III

Board of Directors

Section 1. The Governing Body of the Association shall be a Board of Directors, hereinafter called the Board.

Section 2. The Board shall consist of:

a. The President of the Association.

b. The Treasurer of the Association.

c. One Director to be elected by each Section of the Association.

d. One Director to be elected by the Members of the Water Works Manufacturers Association.

e. The latest living Past President of the Association.

f. The Chairman of the Committee on Water Works Practice.

g. The Chairman of the Publication Committee.

Section 3. The terms of Directors and Officers shall start at the beginning of the last day of the Annual Convention at which they are elected, and shall terminate at the beginning of the last day of the Annual Convention at the expiration of their terms.

Section 4. The President of the Association, and the Directors elected by the Sections of the Association will not be eligible for re-election for consecutive terms.

SECTION 5. The Officers of the Association shall be the Officers of the Board.

SECTION 6. The functions of the Board shall include the following:

a. Establishing policies for the Association, and for the Executive Committee, and for the Officers.

b. Providing for the general administration of the affairs and property of the Association.

c. Fixing the time and place of the Annual, and other, conventions of the Association as provided in the By-Laws.

d. Preparing and enforcing for the conduct of the business of the Association, By-Laws not in conflict with this Constitution, and amending the same.

SECTION 7. A quorum of the Board shall consist of a majority of its members.

SECTION 8. Regular meetings of the Board shall be held during the Annual Convention of the Association, on such days as may be decided by the Board. Other meetings may be held at the direction of the President, or at the request, in writing, of five members of the Board, and on such notice as shall be provided in the By-Laws.

ARTICLE IV

NOMINATION AND ELECTION OF OFFICERS AND DIRECTORS

SECTION 1. There shall be a meeting of the Board held in January of each year at which a Nominating Committee consisting of the Directors representing the various Sections of the Association shall meet under the Chairmanship of the President, and shall nominate one, and may nominate two candidates for each of the offices of President and Treasurer, provided that any candidate so nominated shall be an Active member of the Association, and shall have been a member of the Executive Committee prior to the adoption of the present Constitution and By-Laws, or a member of the Board of Directors since its adoption, and shall signify willingness to accept the nomination. This Committee shall report its list of nominees to the Board before the close of its January meeting, and the list shall then be mailed to the membership before February 1st of that year.

At any time prior to noon on the first day of March of each year additional nominations may be made by request to the Secretary, signed by at least twenty-five Active Members, and upon receipt of such request, the Secretary shall, after acceptance of the nomination

by the candidates, add such names to tne ballot prepared by him. The nominees of the Nominating Committee shall be so designated on the ballot for each office, and the names of all nominees shall be arranged in alphabetical order.

When more than one name is nominated for either office, the election shall be by letter ballot. Each Active Member shall be entitled to vote for one candidate for the office of President, and one candidate for the office of Treasurer. The ballot shall be prepared by the Secretary and mailed to each Active Member of the Association prior to April 1st in each year, and shall state the name and residence of each candidate.

The ballot shall be sealed separately in a special ballot envelope, and the latter shall be enclosed in a larger envelope, and mailed to the Secretary. The signature of the member voting shall appear on the outer envelope.

When a letter ballot is necessary, the Secretary together with two or more Tellers appointed by the President shall meet at a time and place directed by the President, and shall open and count all ballots cast by persons entitled to vote. No ballot shall be counted if received later than noon of the seventh day previous to the beginning of the annual convention of the Association. When only one candidate is placed in nomination for each office to be filled, the report of the Nominating Committee shall be considered as an election.

The report of the Tellers for the election of the incoming President and Treasurer shall be declared by the President at the Annual Convention on certificates of the Tellers. The candidates who shall have received the highest number of votes cast for the several offices shall be declared elected. If there be a tie vote the President shall order a ballot to be taken at the annual convention to decide which of the Candidates who have received the same number of ballots shall be chosen.

The terms of the officers so elected shall be for one year beginning with the last day of the annual convention at which they are elected to the beginning of the last day of the next annual convention, or until their successors shall have been chosen.

In case of a vacancy in the office of President, the office shall be filled by the latest living Past President for the unexpired term of such office.

In the case of a vacancy in the office of Treasurer, the Executive Committee shall appoint an Active Member to fill the office for the unexpired term.

SECTION 2. One Director to represent each local Section shall be nominated and elected by the members of the Section at an annual section meeting, and in the same manner as the presiding officer of that Section is elected. The manner of such election shall receive the approval of the Board. The Director so elected shall be an Active Member.

The term of each Director so elected shall be for three years beginning with the last day of the annual convention immediately following his election, except as stated below:

The following local sections shall elect their Directors during the year previous to the annual convention of the Association in 1930, and such Directors shall serve from the said annual convention until the annual convention in 1931:

North Carolina, Canadian, Wisconsin, Rocky Mountain, Indiana.

The following local sections shall elect their Directors during the year previous to the annual convention of the Association in 1930, and such Directors shall serve from the said annual convention until the annual convention in 1932.

Pacific North West, Missouri Valley, Kentucky, Tennessee, Central States, New York.

The following local sections shall elect their Directors during the year previous to the annual convention of the Association in 1930, and such Directors shall serve from the said annual convention until the annual convention in 1933.

California, Montana, Minnesota, Illinois, Florida, Four-States.

When new local sections are constituted, the initial term of the directors representing such sections shall be determined by the Board.

In the case of the retiring, from any cause, of a Director representing a Section, before his term is completed, the Governing body of the section shall designate his successor, who shall serve for the unexpired portion of the term.

SECTION 3. One Director shall be nominated and elected by the members of the Water Works Manufacturer's Association. His term of office shall be for three years beginnng with the last day of the annual convention immediately following his election.

ARTICLE V

The Executive Committee and officers as constituted under the previous Constitution shall remain in office, and continue to direct

the affairs of the Association until the end of the annual convention in 1930.

The nominations and elections as laid down in the Constitution and By-Laws, accepted by the Association at its annual convention in 1929, shall proceed prior to the annual convention in 1930, and the successful candidates shall take office at the close of the latter convention.

Except as mentioned above the Constitution shall take effect at the end of the annual convention in 1929.

ARTICLE VI

AMENDMENTS

Proposals to amend this Constitution shall be submitted in writing to the Board, signed by at least ten Active Members of the Association.

The Board shall consider the proposals and the proposers shall be notified of the Board's opinion in regard thereto not later than the first day of March. The proposers may then withdraw their proposals, accept any change suggested, or insist on the original form, sending their decision to the Secretary not later than the first day of April. The proposals, as accepted by the proposers, shall be mailed to the Active Members not less than twenty-one days before the annual convention. Proposals to amend this Constitution may also be made by the Board and shall be mailed to the Active Members not less than twenty-one days before the annual convention. All proposals shall be submitted for discussion at the annual convention. The Active Members there present may propose an amendment or amendments thereto, and all proposals together with any such amendment or amendments shall be printed on a letter ballot to be submitted to the Active membership. The Secretary shall issue the letter ballot not later than two months after the annual convention.

On the written request of three or more members the letter ballot shall be accompanied by a statement giving reasons for and against the proposal edited by a Committee appointed by the Board, consisting of an equal number of members favoring and members opposing the proposal.

The letter ballot shall be returnable to the Secretary not later than three months after the annual convention. Three tellers appointed by the Board shall forthwith count the ballots and report the result to the Board.

An affirmative two-thirds vote of all valid ballots shall be necessary for the amendment or repeal of any part of the Constitution.

The amendments as passed shall take effect at the beginning of the next calender year except that changes affecting the tenure of office of an Officer of the Association shall not take effect until the next annual convention.

BY-LAWS

ARTICLE I

Membership

Section 1. The membership of the Association shall consist of Honorary, Active, Corporate and Associate Members.

Section 2. An Honorary member shall be one whose practical or scientific knowledge in matters relating to water supply, and whose accomplishments in that field of endeavor shall entitle him to special recognition by the Association. Honorary members shall have the same privileges as Active Members but shall not be required to pay any dues for the support of the Association.

Section 3. An Active Member shall be a superintendent, a manager, an official or employee of a municipal or private water works: a civil, mechanical, hydraulic, or sanitary engineer, a chemist, a bacteriologist, or any qualified person engaged or interested in the advancement of knowledge relating to water supplies.

Section 4. A Corporate Member shall be a Water Board, Water Commission, Water Department, Water Company or Corporation, National State or District Board of Health, or other body, corporation or organization engaged or interested in water supply work, and shall be entitled to one representative whose name shall appear on the roll of members, and who shall have all the rights and privileges of an Active Member. This representative may be changed at the convenience and pleasure of the Corporate Member on written notice to the Secretary.

Section 5. An Associate Member shall be either a person, firm or corporation engaged in manufacturing or furnishing supplies for the operation, construction, or maintenance of water works.

Section 6. Any Association or Society which is primarily organized to promote the advancement of the art of water supply in any of its branches, and to furnish to its members information relating thereto, shall be eligible for designation by the Board as an Affiliate

Association or Society of the American Water Works Association. Such Association or Society shall submit an application to the Board and upon the application receiving the approval of a majority of the Board, the said Association or Society shall remain an Affiliate at the pleasure of the Board. An Affiliate shall pay no dues, shall exchange publications, and its members who are qualified to become Active members of the American Water Works Association may become so upon application for such Active membership as provided in the By-Laws, without payment of any initiation fee, but shall pay the yearly dues.

ARTICLE II

Admission and Expulsion

Section 1. The Board, on its own initiative, or at the request of twenty-five members of the Association, may elect any qualified person an Honorary Member. This election shall take place at a regular meeting of the Board and shall be by ballot. Two negative ballots shall exclude.

Each Honorary Member shall receive an engrossed certificate of membership in that grade.

Section 2. Applications for Active, Corporate, or Associate Membership shall be made on the blank forms provided by the Association. Each application shall embody a concise statement of the applicant's qualification for membership. All applications shall be forwarded to the Secretary who shall submit them to the Board.

An affirmative vote of a majority of the Board shall elect and the applicant shall become a member when initiation fees and annual dues shall have been paid.

Section 3. No member whose dues are in arrears for four months shall receive the publications of the Association until such arrears are paid. Members in arrears for one year shall be automatically dropped by the Secretary from the list of members.

Section 4. The Board may, for sufficient cause, temporarily or permanently excuse from the payment of annual dues, any member who from ill health, advanced age, or other good reason, is unable to pay such dues, and the Board may remit the whole or part of dues in arrears, or accept in lieu thereof desirable additions to the library or collections.

SECTION 5. A member who has been dropped for non payment of dues may be re-instated by the Board on payment of the arrears. He shall then be entitled to receive such back numbers of the publications of the Association as may have been withheld from him on account of non payment of dues, and are available for distribution.

SECTION 6. Any member of any grade may be expelled from membership in the Association, by a three-quarters vote of the Board, taken by letter ballot, provided such member has been given a written statement of the charges preferred, and has been accorded an opportunity of a hearing before the Board.

SECTION 7. Any member may retire from membership by giving written notice to the Secretary, provided that he is in good standing.

ARTICLE III

FEES AND DUES

SECTION 1. Each Active Member shall pay an initiation fee of Five dollars, and annual dues of Ten dollars, provided that any Active member in good standing who has paid dues continuously for thirty years shall be exempt from payment of further dues. No initiation fee shall be required from a member in good standing of an Affiliate Association or Society, who has been elected as an Active Member.

SECTION 2. Each Corporate Member shall pay an initiation fee of Ten dollars, and annual dues of Fifteen dollars.

SECTION 3. Each Associate member shall pay an initiation fee of Ten dollars, and annual dues of Twenty-five dollars.

SECTION 4. The fiscal year of the Association shall begin on January 1st., and terminate on December 31st. Annual dues shall be payable in advance, and shall be due on January 1st. in each year. It shall be the duty of the Secretary to notify each member on or before December 31st. in each year of the amount due from said member for the ensuing year.

SECTION 5. Any newly elected member shall be entitled to all of the publications of the Association that are distributed to its members during the year, or that part of the year, for which he has paid dues.

ARTICLE IV

Executive Committee

There shall be an Executive Committee of five members consisting of the President, and four Directors. This committee shall be chosen by the Board at its meeting at the annual convention.

The President of the Association shall act as Chairman of the Committee, or in his absence, the Committee shall choose a temporary chairman from its members, and the Secretary of the Association shall act as its Secretary.

The duties of the Committee shall be to direct the administrative work of the Association and to carry out the policies of the Board between meetings of the latter.

A quorum of the Committee shall consist of three members.

ARTICLE V

Duties of Officers and Directors

Section 1. The President shall have general supervision of the affairs of the Association, and shall preside at all conventions of the Association, and meetings of the Board. In his absence he shall designate a presiding officer to act in his stead at such conventions or meetings. He shall be, ex-officio, a member of all committees.

Section 2. The Board of Directors shall be the legal representatives of the Association, and as such shall have full control of the Association in regular convention. It shall make the necessary arrangements for the conventions, and shall have power to expend the funds of the Association, or to invest the same, but must not incur indebtedness beyond the funds in the hands of the Treasurer and Secretary. It shall hold a meeting during the last day, and also a meeting at least one hour before the opening session of each annual convention. Other meetings shall be held at the call of the President, or of any five members of the Board. Notice of all meetings shall be issued by the Secretary at least ten days in advance of such meetings to all members of the Board.

Except as otherwise provided in the Constitution and By-Laws, all questions before the Board shall be decided by a majority vote.

Section 3. The Treasurer shall have charge of the funds of the Association, and shall pay bills against the Association when certified by the Secretary and the President. He shall make a report of the expenditures and of the funds of the Association at the annual con-

vention. He may, with the approval of the Board, establish a drawing account for the Secretary.

He shall be bonded at the expense of the Association and to an amount to be determined by the Board.

He shall perform such other duties as may be assigned to him by the Board.

SECTION 4. The Secretary shall be an Active Member of the Association. It shall be his duty to attend all conventions and meetings of the Association, and of the Board, prepare the business and duly record the proceedings thereof. He shall see that all moneys due the Association are collected, and shall promptly deposit the same to the credit of the Association. He shall certify to all bills against the Association, and once each month he shall forward to each member of the Board, a financial summary of receipts and disbursements.

He shall, at the annual convention, make a report of the receipts and of the condition and affairs of the Association.

He shall have charge of the books and records of the Association and shall supervise the work of all employees.

The books of the Association shall be audited annually by Certified Public Accountants, to be appointed by the Board.

He shall be bonded at the expense of the Association and to an amount to be determined by the Board.

He shall perform such other duties as shall be assigned to him by the Board.

SECTION 5. The Editor shall have charge of the printing and distribution to all the members of the proceedings and transactions of the Association, and shall perform such other duties as shall be assigned to him by the Board. He shall be, ex-officio, a member of the Publication Committee, and of the Committee on Water Works Practice.

ARTICLE VI

CONVENTIONS OF THE ASSOCIATION

The annual convention of the Association shall be held at a time and place to be selected by the Board. Additional conventions of the Association may be held at such times and places as may be selected by the Board. Meetings of the Sections shall be held as determined by the Constitutions of the Sections. All conventions and meetings shall be conducted according to "Roberts Rules of Order."

Each member and guest present at any of the conventions of the Association shall pay a registration fee of such amount as may be determined by the Board.

ARTICLE VII

Sections and Divisions

Section 1. Local Sections may be established by the Board on receipt of a written request to that effect signed by twenty Active or Corporate Members of the Association residing in the territory within which the local section is desired. The territory embraced by each local section shall be fixed by the Board.

Section 2. National Divisions consisting of Superintendents, Engineers, Chemists, Bacteriologists, and Accountants or other classes of persons included in the membership of the Association may be established by the Board on the request of thirty members. Any member of the Association may register in any National Division of the Association in which he is interested.

Section 3. Such Local Sections and National Divisions which shall consist only of members of this Association in good standing shall elect their own officers and committees, and may make any rules for their government not inconsistent with the Constitution and By-Laws of the Association, but these rules must first be approved by the Board.

Section 4. Each Local Section as soon as established, and after its rules have been approved by the Board, may with its approval annually receive from the Treasurer of the Association for local use not more than twenty-five per cent of the annual dues paid to the Association by the members of the said local section as shown by the books of the Association on the 1st. day of November of each year, unless the Board increases the amount allowed to any local section, the amount of such increase to be determined by the Board, and to be allowed only when in the judgment of the Board the work undertaken by that local section is such as to be of material benefit to the Association. Unless the Board increases the amount allowed the total money received by any local section for any one fiscal year shall not exceed the sum of $300. Local Sections having small membership shall be entitled to receive from the Association $100 in any one fiscal year, even though the alloted 25 per cent of the annual dues paid to the Association by the members of the said local section does not amount to $100.

Each National Division when established and its rules and Constitution have been approved by the Board, may with the approval of the Board, annually receive from the Treasurer of the Association a sum not exceeding $100 for Division expenses.

The Treasurer of each Local Section or National Division shall forward to the Secretary of the Association his application endorsed by the presiding officer of the section or division for such portions of the said sums above specified as may be needed and upon receipt of such application the Secretary shall authorize the Treasurer of the Association to pay such sums to the Treasurer of the Section or Division. These moneys may be used by the Section or Division only in payment of necessary operating expenses.

At the end of each fiscal year the Treasurer of each Section and Division shall submit a certified copy of his accounts to the Secretary of the Association, the same being itemized and showing the balance on hand of funds received from the Association which will remain to the credit of such section or division until such section or division is dissolved or the Board shall otherwise order their return to the treasury of the Association.

SECTION 5. Any member of the Association who resides in a locality which is not included in the territory embraced by an existing local section, may upon written request to the Board be included in the membership of any local section. The Secretary of the Association shall notify the Secretary of the local section of the enrollment of the member.

Whenever a new local section is formed or an existing local section has its territory extended which will include in its territory the locality where such member resides, he shall automatically be included in the membership of such local section.

SECTION 6. Any Section or Division may be dissolved by the Board for reasons which it believes are good and sufficient.

ARTICLE VIII

PUBLICATIONS

All Publications of the Association shall be issued under the direction of the Board and shall be copyrighted as far as is practicable and proper.

ARTICLE IX

Committees

Section 1. A Publication Committee shall be appointed by the Board at the annual convention of the Association. It shall consist of at least five members, at large, and its Chairman shall be ex-officio, a member of the Board.

It shall have control of the publications of the Association, including the programs of its conventions and shall see that all publications and papers are edited before publication.

The Committee shall prepare rules which shall govern the preparation, presentation, acceptance, and publication of all papers and such other matters of a similar nature as the best interests of the Association may require.

Section 2. A Committee on Water Works Practice shall be appointed by the Board at the annual convention. It shall consist of at least five members, at large, and its Chairman shall be ex-officio, a member of the Board.

Any Resolution, Report, or Publication which undertakes to establish in the name of the Association, or any of its sections or divisions, professional or technical standards, shall be submitted to this committee, and it shall direct all such matters on behalf of the Association.

It shall give notice by publication to the membership of all such proposed standards and report its approval or disapproval of such to the Board.

It shall appoint such sub-committees as it may deem necessary to properly carry on its work.

Section 3. The Board shall appoint such other committees as may be necessary to carry on the work of the Association.

ARTICLE X

The Board of Directors may amend these By-Laws in any manner not inconsistent with the Constitution by a two-thirds vote of those voting at any meeting of the Board or by sealed letter ballot, providing that a copy of such proposed amendment has been mailed by the Secretary to each member of the Board at least thirty days prior to such meeting or letter ballot.

SOCIETY AFFAIRS

ROCKY MOUNTAIN SECTION

The Rocky Mountain Section held its third annual meeting in Denver, February 14 and 15, 1929. A registration of 28 members and 55 guests, considerably more than that at any previous meeting, indicates the growth of interest, in the section and its activities.

The address of welcome was delivered by Hon. C. C. Schrepferman, President of the Board of Water Commissioners of Denver. The technical papers presented were as follows:

Distribution Systems and Service Pipes. P. R. Revis, City Engineer, Cheyenne, Wyoming.

A Small Filtration Plant. Chester Truman, Superintendent, Northfield Water Company, Colorado Springs, Colorado.

La Junta's Sewage Pumping Plant. Geo. E. Hine, City Engineer, La Junta, Colorado.

Taking the Hardness out of Water. R. E. McDonnell, Kansas City, Missouri.

Engineering Problems in Connection with Water Rights. Geo. M. Bull, Consulting Engineer, Board of Water Commissioners, Denver, Colorado.

Legal Problems in Connection with Water Rights.[1] Malcolm Lindsey, Attorney, Board of Water Commissioners, Denver, Colorado.

Wells as a Source of Municipal Water Supply. Wynkoop Kiersted, Jr., Kansas City, Missouri.

Round Table Discussions were held on mechanical vs. slow sand filters, prechlorination, and miscellaneous water works subjects.

Talks illustrated with lantern slides and motion pictures included:

The St. Francis Dam Failure, by R. E. McDonnell.

Water Purification and Sewage Treatment Equipment, by E. M. Kelly, representing The Dorr Company.

Pipe Line Construction at Colorado Springs, by J. J. Wilson, representing the National Tube Company.

[1] This Journal, page 609.

Trenching Machines, by T. R. Elkins, representing the Wilson Machinery Company.

Demonstrations of coagulation, filtration and zeolite softening were given by E. W. Lasley, Vice President, The Flox Company, and Dana E. Kepner, Colorado State Sanitary Engineer, both of Denver, Colorado.

Inspection trips included the shops and equipment yard of the Denver Municipal Water Works, where demonstrations of tapping and other pipe work were given; and the plant of the Gardner-Denver Company, where the manufacture and operation of compressed air tools were shown.

Vaudeville entertainment, following the annual banquet, was made possible by a small registration fee paid by non-members.

The election of officers resulted as follows:

Chairman: P. R. Revis, Cheyenne, Wyoming.

Vice Chairman: D. D. Gross, Denver, Colorado.

Secretary-Treasurer: Dana E. Kepner, Denver, Colorado.

Directors (elected): E. C. Gwillim, Sheridan, Wyoming; Wm. W. Nielson, Santa Fe, New Mexico.

Directors (held over): D. V. Bell, Rock Springs, Wyoming; Paul S. Fox, Santa Fe, New Mexico; E. A. Lawver, Ft. Collins, Colorado; A. W. Stedman, Canon City, Colorado.

Exhibits of water works equipment were omitted, at the request of the Manufacturers Association.

DANA E. KEPNER,
Secretary-Treasurer.

THE INDIANA SECTION

The attendance at the twenty-second annual meeting of the Indiana Section held at Indianapolis on February 26 and 27, 1929, was up to par, 170 people being registered, which included fourteen ladies, wives of the members. All sessions were attended by Beekman C. Little, Secretary of the American Water Works Association, who spoke briefly to the section at the luncheon and entered into the discussion of the various papers.

On the second afternoon of the meeting two separate sessions were held; one for plant operators, and one for the discussion of fire prevention problems.

Dr. M. C. Balfour, of the Rockefeller Foundation, was a guest at the luncheon and addressed the meeting on the work of the Foundation as it affected sanitation.

Chas. E. Trowbridge, of the American Water Works and Electrical Company, addressed the general session on "Tastes and Odors" and also addressed the operators division on "General Filter Operation."

A very scholarly paper on "Iron Removal" was presented by Robert L. McNamee of Ann Arbor, Mich.

Thomas J. Skinker of St. Louis reported on St. Louis' experience in cleaning water mains The problem in St. Louis was particularly acute on account of the long use of unfiltered water in the early years.

Indianapolis' practice in sterilization of new mains was discussed by John A. McClintock and it was interesting to note that the practice of sterilizing new mains is spreading and is routine in many cities at this time. In some cases it is found that two or three applications of chlorine are necessary to effect complete sterilization.

The increased use of leadite was brought out in the paper by W. C. Mabee of Indianapolis, and in the discussion which followed Mr. Skinker referred to a test made at St. Louis in which a pressure of more than 1400 pounds per square inch was applied without failure of a leadite joint.

A very interesting discussion was started by a paper by W. H. Durbin on "Increasing Sales of Water Service."

Indiana State Forester, Ralph F. Wilcox, addressed the general session on reforestation and its effect on water conservation. He made the statement that many impounding reservoirs in Indiana as well as over the country were being filled very rapidly by eroded soil which could be prevented by reforestation of the water shed.

The dinner meeting was addressed by Dr. Thurman B. Rice of the Indiana School of Medicine. Dr. Rice is a splendid speaker and his address was received enthusiastically by the audience. It has been many years since the Association has had such a delightful after dinner speaker.

The rapid change in municipal employees was decried in a paper by John W. Moore or Indianapolis. In the last year in Indiana at least sixty changes have taken place among the operators of municipal water plants.

J. R. Stephenson described the recent modification of the Elkhart plant.

The early use of the small size service was discussed in a paper by D. T. Salmon of Ft. Wayne and discussion indicated that present practice is to use services of materially larger sizes.

The papers by Clarence Goldsmith and Percy Bugbee were pre-

sented to the general session, but the discussion of these papers was carried on in a separate fire prevention division in the afternoon. This division was very well attended, the discussion lively, and of very great importance to the water works superintendents and fire chiefs in attendance. Mr. Frank C. Jordan presided at this session.

At the operators division L. S. Finch of the Indiana State Board of Health presided. The papers presented were on practical operation of purification plants and included "The Control of Chlorination" by E. H. Parks; "The Care and Operation of Chlorination" by Fred Merkel; "The Value of Pre-Chlorination" by Harry E. Jordan; "Control of Economical Coagulant Dosage" by Neil Kershaw; and "Filtration Operation" by Chas. E. Trowbridge. The importance of this session is indicated by the interest of the members. It was well attended until it closed at a late hour in the afternoon.

In attendance, quality of papers, and interest of those at the meeting it is felt that the Indiana Section had one of the most interesting meetings in its history.

Officers elected for the coming year are: President: I. L. Miller; Vice-President: W. C. Ridgeway; Secretary-Treasurer: C. K. Calvert; Assistant Secretary: L. S. Finch.

Executive Committee: C. E. Stewart, Muncie, Ind.; J. W. Moore, Indianapolis, Ind.; J. F. Bradley, Valparaiso, Ind.; Howard A. Dill, Richmond, Ind.; Earl L. Carter, Indianapolis, Ind.; George Waldrop, Ft. Wayne, Ind.; H. S. Morse, Indianapolis, Ind.; F. C. Jordan, Indianapolis, Ind.; G. J. Oglebay, Indianaplis, Ind.

C. K. CALVERT,
Secretary-Treasurer.

ABSTRACTS OF WATER WORKS LITERATURE[1]

FRANK HANNAN

Key: American Journal of Public Health, 12: 1, 16, January, 1922 The figure 12 refers to the volume, 1 to the number of the issue, and 16 to the page of the Journal.

New Pumping Equipment for Milwaukee Water Works. HERBERT H. BROWN. Eng. News-Rec., 100: 843–5, May 31, 1928. When Riverside station, Milwaukee, was placed in service, it was equipped for only half proposed ultimate capacity. Three vertical triple-expansion pumping engines were installed, 2 of 22-million gallons per day capacity under 280-foot head and a third of 25-million gallons per day capacity under 170-foot head. In boiler room three 400-horse power, 4-pass water-tube boilers were installed with auxiliary equipment, including underfeed stokers, convection type superheaters, soot-blowers, forced draft fans, oil-removal filters, and water softeners. Pivoted bucket conveyor carries coal to overhead concrete bunkers, from which it is spouted and weighed to each boiler. Rapid growth of city and corresponding increase in demand necessitated increased pumping capacity earlier than anticipated, a new pump and additional boilers being added in 1927. Careful observations on the 4-pass boilers brought out 3 important facts: (1) they could not be operated over 165 per cent of rating. (2) draft loss through boilers was exceedingly large; and (3) as heat-absorbing and transferring units they were satisfactory. It was therefore decided to design new units with either greater length between headers or else with only 2 flue-gas passes. Latter was adopted owing to limited space. Equipment includes superheaters of convection type and mechanical stokers. Data from acceptance tests given. Flue-gas temperature was 82° higher and carbon dioxide content 0.7 per cent lower in the 2-pass than in the 4-pass units. Notwithstanding higher flue-gas temperature, over-all efficiency of 2-pass units was 2.37 per cent higher. This can be attributed only to better absorption of radiant heat. Boiler developed 223.5 per cent rating for average of six hours with maximum of 263 per cent for short period. During six-hour test average draft loss was 0.37 inch of water at 223.5 per cent of rating. At 105.8 per cent of rating draft loss was only 0.045 inch of water. Draft loss through 4-pass boilers was 0.375 inch at 109.5 per cent of rating and 0.74 inch at 156 per cent of rating. Most radical change in equipment was selection of 40-million gallon per day steam-turbine-driven centrifugal pump. Vertical triple-expansion pumping engine has long been

[1] Vacancies on the abstracting staff occur from time to time. Members desirous of coöperating in this work are earnestly requested to communicate with the chief abstractor, Frank Hannan, 285 Willow Avenue, Toronto 8, Ontario, Canada.

standard of Milwaukee works. In 1887 first engine of this kind in world was installed at Milwaukee. In 1891 an 18-million gallon per day unit was installed which held world's record for efficiency. This engine is still rendering excellent service after thirty-seven years' continuous operation. Since then 13 similar units have been installed. When official acceptance test was carried out in January, 1925, world's record of efficiency again returned to Milwaukee, duty of 214,545,000 foot-pounds per 1000 pounds of steam being developed. Centrifugal unit was selected after consideration of all factors, including initial cost, "use factor" (50 per cent), etc.—*R. E. Thompson.*

Underground Water Supplies, and the Need for Investigation of the Sources Thereof. S. R. RAFFERTY. Munic. Eng. Sanit. Record, **80**: 676–7, 1927. From Chem. Abst., **22**: 1000, March 10, 1928. Discussion of ways and means of estimating amount of water obtainable from underground sources.—*R. E. Thompson.*

New Pumping and Water Treatment Works for New Orleans. Eng. News-Rec., **100**: 858, May 31, 1928. New purification works, now 75 per cent completed, will include 2 grit and 2 chemical mixing chambers, 4 coagulation basins, and eighteen 4-million gallon per day filters. New plant, adjacent to and cross-connected with original 40-million gallon per day plant of 1909, will be capable of independent operation so that old plant can be put out of commission for overhauling. Additional low lift pumping station is being constructed, housing 3 centrifugal pumps driven by 6 synchronous motors arranged for operation through wide range of quantity and lift. New equipment also includes 3 boilers of 4000-horse power capacity each, equipped to operate with powdered coal, oil or gas, installed in water works pumping station which supplies power to new station.—*R. E. Thompson.*

Sand Control Works at Fort Laramie Canal Intake. IVAN E. HOUK. Eng. News-Rec., **100**: 922–6, June 14, 1928. Illustrated description of works constructed for controlling sand at Whalen Dam, North Platte Irrigation Project consisting of settling basin, skimming weir, and sluiceway below intake.—*R. E. Thompson.*

Colorado River—Los Angeles Aqueduct Project. H. A. VAN NORMAN and E. A. BAYLEY. Eng. News-Rec., **100**: 850–4, May 31, 1928. Although great water supply development that brought water 250 miles from Owens Valley was completed only fifteen years ago, city has advanced to point where another and still greater supply must be provided. Studies of all available sources and, later, extensive surveys and preliminary plans for an aqueduct from Colorado River have been carried out with bond issue of $2,000,000 which was voted for purpose in 1925. Proposed aqueduct, about 300 miles long, has been designed for ultimate capacity of 1500 second-feet (970 million gallons per day), or enough to supply Los Angeles metropolitan water district for next fifty years. Little more can be done until proposed Colorado River storage and power project has been put on more definite basis. Population supplied by Los Angeles Bureau of Water Works and Supply is about 1,230,000 and in-

crease has averaged more than 70,000 per year for last ten years, at which rate city will reach limit of present supply within ten years. Metropolitan water district Act passed by California Legislature in 1927 is general enabling act, but was framed with particular reference to needs of southern California communities in preparing to join in development of Colorado River water supply. If aqueduct is carried forward as now expected under metropolitan district plan, cost will be apportioned among municipalities on basis of assessed valuation. Some 38 cities and towns have indicated interest, although final decision is left to voters. Only available water is flood flow, as low water flow of river is fully appropriated. Hardness of water is 251 p.p.m. Estimated cost is $150,000,000 to $200,000,000, depending on power cost and location and design.—*R. E. Thompson.*

Graphitization of Cast Iron. R. STUMPER. Korrosion u. Metallschutz, 3: 265–8, 1927. From Chem. Abst., 22: 936, March 10, 1928. Discussion of factors causing graphitization of cast iron and experimental data to prove that graphitization can occur in running water.—*R. E. Thompson.*

Small Surface-Well Water Supply with Automatic Control. Eng. News-Rec., 100: 854, May 31, 1928. Shallow well supply of Marengo, Ill., town of 1800 people, having become inadequate for fire protection, a new supply has been developed. Consumption is 95,000 gallons, or 53 gallons per capita per day. After comparison of possible projects, additional well 25 feet in diameter and 23 feet deep was decided upon. Well was constructed by building reinforced concrete shell and sinking it by excavation from interior. Electrically-driven centrifugal pump delivers water for domestic purposes directly to mains, pressure of 45 pounds per square inch being equalized by 6300-gallon standpipe. Additional pump has been added for fire service. Pump for domestic service is controlled automatically by self-starting pressure gage. Fire pressure of 80 pounds per square inch is thrown in by remote control from fire station. Curve given, developed during studies, showing relation between inflow and static head on existing well, 20 feet in diameter and 20 feet deep. Yield from bottom of this well, which is in fine water-bearing sand and gravel, increased as square root of depth to which water in well was pumped below outside ground water level. In other words, inflow follows same law as inflow through small pipes.—*R. E. Thompson.*

Greater Vancouver Water District. Eng. News-Rec., 100: 863, May 31, 1928. Greater Vancouver Water District includes Vancouver, B.C., and 6 adjacent municipalities with population of 275,000. Consumption for 1927 was 10,377 million gallons. Administrative board is composed of representatives for each municipality appointed by respective city councils. Chief executive is commissioner appointed by board. Water supply is by gravity from 2 independent sources, Capilano and Seymour Greeks, both regulated by mountain lake reservoirs. Drainage areas are held under 999 years lease. Former is free of pollution, but on latter there are small logging operations. Sanitary regulations are stringently enforced. Value of supply system is $6,500,000. No treatment is necessary. Water is metered in bulk to various municipalities

and distributed by them. Cost of water in bulk is about 4½ cents per 1000 gallons.—*R. E. Thompson.*

Trunk-Main Water Distribution System for Greater Detroit. Louis E. Ayres. Eng. News-Rec., 100: 855–8, May 31, 1928. Exhaustive studies were made of water supply problem of Detroit over period of four years, and in 1925 definite plan was adopted capable in its ultimate development of furnishing water to 3½ to 4 million persons who, it is estimated, might reside within area of 300 square miles including present city (then less than 100 square miles in area) at some time between 1950 and 1960. Principal features of plan for distribution to metropolitan area are described. Ultimate plan includes greater metropolitan area of about 1800 square miles. Plan, as developed, contemplates distribution of water within 300 square miles from 3 principal distributing centers, for most part by direct pressure, but to more remote and higher areas through electric booster stations, and has been worked out to fit in with ultimate development. Present single station has filter capacity of 360 million gallons per day and maximum pumping capacity of 460 million gallons. Maximum consumption last year was at rate of 390 million gallons per day. Increase in maximum rate expected in immediate future is 20 million gallons per day. Use of steel in lieu of cast iron for mains larger than 36 inches in diameter is advocated in order to avoid repetition of serious breaks in large cast iron mains experienced in past. Elevated storage tanks are planned in booster areas. Tanks thus far installed have capacity of 1.5 million gallons contained between 2 horizontal planes 50 and 100 feet, respectively, above ground surface at site. Capacity of 2 million gallons is being considered for future tanks.—*R. E. Thompson.*

Pipe Lines Jacked for 200 Feet Through Railroad Fill. M. P. Mellon. Eng. News-Rec., 100: 945, June 14, 1928. Brief illustrated description of jacking of four 6-inch wrought iron lines through distance of 200 feet. Old hydraulic cylinder with 6-inch piston and 5-foot 3-inch stroke was used in connection with motor-driven hydraulic jack pump. Gage readings on pump at times showed pressure reaching 4500 pounds per square inch, but usual pressure required was 2000 pounds. Time consumed was fifteen hours for each line.—*R. E. Thompson.*

A Question in Financing Water Service Connections and Meters. W. C. Hawley. Eng. News-Rec., 101: 30, July 5, 1928. Public service commissions, with approval of courts, in practically all of the states have decided that water companies should furnish service line from main to curb and water meter without cost to consumer. Question has been raised as to whether there should be portion of service charge, minimum rate, or flat rate, or whatever basis of charge, that shall be charged against properties in which water utility has investment in service line or meter which are not taking service. Number of such properties may range from 2 to possibly as high as 5 per cent of total number of taps.—*R. E. Thompson.*

Operating Problems of Pneumatic Alum Conveyor System. J. ARTHUR JENSEN. Eng. News-Rec., **100**: 931, 1928. When the pneumatic filter alum conveyor was installed at the new Fridley filtration plant in Minneapolis, it was equipped with rotary locks for delivery of the alum from the receivers to atmospheric pressure. These have been found unsatisfactory owing to alum dust entering the drum bearings and causing friction. "Stop" or gate locks have been substituted and found satisfactory. An intensely hard scale was found to accumulate at the bends in the iron conveyor line, reducing the capacity of the plant. This difficulty has been eliminated by substituting flanged rubber hose at the bends.—*R. E. Thompson* (*Courtesy Chem. Abst.*).

New Jersey Dams Controlled by State. Eng. News-Rec., **100**: 822, May 24, 1928. Control over all dams in New Jersey having tributary drainage area of more than 1 square mile has rested with Division of Waters of New Jersey Board of Conservation and Development since 1916. Recent action of legislature has reduced exempt area to ½ square mile. Plans and specifications must be approved before construction commences. Site is closely inspected, frequent inspections are carried out during construction, and final inspection is made before permission is granted to start impounding water. As result of these precautions, not one of 140 dams erected under state supervision has failed. Existing dams are also examined, and if found unsafe, owner is required to make adequate repairs or unwater. This activity has resulted in repair of 5 dams and unwatering of one.—*R. E. Thompson.*

Backwater Slopes Above Dams. C. I. GRIMM. Eng. News-Rec., **100**: 902, June 7, 1928. Writer describes method devised for computing backwater slopes above dams for channels that have been estimated without dam. Method involves principles of Chezy and similar formulas, but is simpler and probably more reliable.—*R. E. Thompson.*

Computation of Backwater Slopes. J. B. MACPHAIL. Eng. News-Rec., **100**: 1017, June 28, 1928. More general form of method of C. I. GRIMM (Cf. previous abstract) suggested.—*R. E. Thompson.*

Hydro-Electric Redevelopment on Missouri River. R. A. MONCRIEFF. Eng. News-Rec., **101**: 48–51, July 12, 1928. Illustrated description of new plant (27,000 h.p. under 50-foot head) completed in 1927 at Black Eagle Falls by Montana Power Co. New concrete dam, 50 feet downstream from old one, is about 830 feet long and raises water 25 feet above streambed. Structure is of ogee gravity section.—*R. E. Thompson.*

Deficiencies in Dam Design as illustrated by the St. Francis Failure. M. H. GERRY, JR. Eng. News-Rec., **100**: 983, June 21, 1928. Author believes: (1) That failure was due, primarily, to deficiencies in design. (2) That design used was result of unwise confidence in theory now generally applied to masonry dams. (3) That this theory ought to be replaced by more accurate and logical methods of design. (4) That kind and quality of rock, as softened

and lubricated by water, was only immediate cause of movement. He contends that no masonry dam should be built (1) depending on friction at base to hold it in place; (2) without deep foundations, so designed as to distribute load far down into rock; or (3) without providing, as integral part of structure, a definite barrier against unbalanced water pressure acting near surface. Failure of dam may be traced in no small degree to overconfidence in infallibility of "accepted theory of gravity dam design."—*R. E. Thompson.*

Avoid Overconfidence in the Grouting of Dam Foundations. H. A. RANDS. Eng. News-Rec., 100: 1017, June 28, 1928. Grouting in connection with high dams should be considered only as extra or precautionary measure to aid in preventing lose of water by seepage or percolation. Grouting may be highly successful in firm rock having definite cracks and seams where there is no water moving under pressure, but it is of doubtful efficiency in rock formation such as conglomerate.—*R. E. Thompson.*

Water Supply and Distribution at Portland, Ore. BEN S. MORROW. Eng. News-Rec., 100: 859–60, May 31, 1928. Water supply of Portland is obtained from Bull Run River at point 25 miles east of city. Entire 102 square miles of watershed is located within Bull Run Forest Reserve, a heavily timbered, uninhabited area set aside in 1892 for purpose. Trespassing and grazing of stock are prohibited by act of Congress. Average flow of river is 500 million gallons per day, but low flow is only 41 million gallons per day. Bull Run Lake has heretofore been used for storage and second storage project, Bull Run dam, is under construction. Dam is of gravity section, 200 feet high, curved in plan to 600-foot radius. Crest length is 950 feet and dam will contain 230,000 cubic yards of concrete. Reservoir will have capacity of 11,000 million gallons, sufficient to insure minimum supply of 185 million gallons per day. Water is conveyed through 3 steel conduits of 25, 50, and 74 million gallons per day, respectively, to 2 high-gravity reservoirs in city. Only 4 per cent of water delivered is pumped. The city population of 361,000 is supplied through 83,842 services, all metered. Meter rates are 9½ cents per 100 cubic feet for first 20,000 cubic feet and 7½ cents for all over that amount. Average daily per capita consumption in 1927 was 97.5 gallons. It has been found that in residential district where there is extensive use of water for lawns, etc., maximum hourly rate is 4 times the annual average rate. Normally no treatment is required, but at present time a chlorination plant is maintained at diversion on account of employment of some 500 men above headworks on construction work.—*R. E. Thompson.*

Hydraulic-Fill Dam to be Highest Ever Built. Eng. News-Rec., 101: 124–6, July 26, 1928. With its bulk of 1,800,000 cubic yards rising to height of 245 feet above bedrock, new Cobble Mountain dam will be highest earth dam ever constructed. Heights of 10 other earth dams given for comparison. Crest length is 700 feet, and thickness from toe to toe is 1505 feet. Dam is part of water supply development of Springfield, Mass., on Little River. Reservoir formed, covering 1120 acres, will have capacity of 22 billion gallons. Details of design and construction included.—*R. E. Thompson.*

Earth and Rock-Fill Dam for Irrigation. C. J. ULLRICH. Eng. News-Rec., 100: 864–6, May 31, 1928. Pleasant Valley Dam, of Price River Water Conservation District, takes place (built on new location) of Mammoth Dam, on branch of Price River, which failed in 1917 due to faulty construction (Eng. News-Rec., July 5, 12, and 26, 1917, pages 42, 52, and 189). Reservoir has capacity of 61,000 acre-feet. Dam is of earth and rock-fill type, with maximum height of 63 feet above streambed and 78 feet above bed-rock. Rear portion is rock fill with downstream slope of 1 on 1½, while that of upper side is 1 on ¾. Against this is placed earth fill, upstream side of which has slope of 1 on 3 paved with 12 inches of rock riprap. Top width is 20 feet; 6 feet rock fill and 14 feet earth. Total cost was $600,000; that of dam alone, $130,000. Cost per acre-foot of water stored in reservoir is $12.30 and cost to consumer over 20-year life of bond will be $26 per acre-foot. Data on settlement and seepage are included. Dam settled 18 inches at center, but there was practically no settlement near ends. Settlement was 6 inches greater on rock-fill side than on earth-fill side.—*R. E. Thompson.*

Novel Method for Operating Pump Controls by Main Pressure. FRANKLIN HENSHAW. Eng. News-Rec., 100: 943–4, June 14, 1928. Brief description of automatic control of Scarsdale pumping station. Standpipe is located ¼ mile from station. As drop of only 8 feet was allowed in standpipe before refilling, control contacts had to be set very close together. When a pump first started heavy pressure was created in 16-inch force main before water could get into motion and control contacts were much too close together to permit this sudden increase of pressure to pass freely to gages. By use of an air chamber made from two needle valves and piece of 8-inch pipe 6 feet long (illustrated), transmission of pressure to gages can be so retarded that water in force main gets into motion and excess pressure drops before pressure increases more than ½ pound. By setting cutoff control on the 3 gages at different points to allow for different pressures created in force main according as 1, 2, or 3 pumps are in operation and then throwing a few switches, station can be set in operation on any combination of pumps desired.—*R. E. Thompson.*

The New Waterworks for Scarborough, England. I. Water and Water Eng., 30: 359, 506, November 20, 1928. A description of the procuring of additional water for Scarborough, England, through boring a new well. Details of the new pumping station with its equipment are also given.—*Arthur P. Miller.*

The Prestwood Pumping Station of the South Staffordshire Waterworks Company. Water and Water Eng., 30: 359, 497, November 20, 1928. Increasing demand for water caused the South Staffordshire Waterworks Company of England to seek additional supplies. This article describes the boring of new wells, the pumping station, and the station equipment. Information concerning the tests of the wells is given.—*Arthur P. Miller.*

Chemical and Physical Changes in the Sub-Surface Parts of Deep-Well Structures (Chemische und Physikalische Zustandsänderungen gusseiserner Rohrbrunnen im Untergrunde). G. THIEM. Gas- und Wasserfach, 51, 1239, De-

cember 22, 1928. The author maintains that cast iron continues to be the most acceptable material to be used for strainers in deep wells, and cites in support thereof his examination of strainers in Meerane and Leipzig which had been in service thirty and forty years, respectively.—*R. F. Wagner.*

The New Waterworks for Scarborough, England. II. Anon. Water and Water Eng., 30: 360, 547, December 20, 1928. The Scarborough, England, filtration plant has been enlarged by the addition of a new precipitating tank and six additional filter units. The coagulation process has been centralized in a new building to the rear of the filter house. Also a new pulser-type chloronome has been provided as an extra safeguard. The new buildings and some of the difficulties encountered in constructing the pump station are described. Information is also given concerning a new pipe line, a new reservoir, and the covering of an old reservoir built in 1872.—*Arthur P. Miller.*

The Water Supply of the Glasgow District. Anon. Water and Water Eng., 30: 360, 549, December 20, 1928. This writer discusses the geology of the territory about Glasgow, Scotland, particularly with reference to the procurement of water. He then sketches the various projects through which Glasgow passed to arrive at its present water supply source and system. Loch Katrine, about 25 miles from Glasgow is the source. This glen water is quite pure and soft. Future demand can be cared for by raising the dam at Loch Katrine, thereby increasing the storage.—*Arthur P. Miller.*

The Consumption and Waste of Water. JOHN BOWMAN. Water and Water Eng., 30: 360, 552, December 20, 1928. With the improvement of living and housing conditions and the consequent substitution of new and modern houses for those of older design, there has developed an increasing demand for water. It seems reasonable to think that this demand will continue to increase and that the water supply problem may become even more acute in many places than it now is. High water consumption is due in part to waste, either through extravagance or faulty fittings, and as the demand for more water increases attention to the elimination of waste must also increase. The article is supported by charts on water consumption and by some actual examples illustrating the theoretical conclusions.—*Arthur P. Miller.*

The Sandfields Filtration Installation, with Special Reference to Some Chemical and Bacteriological Observations. ARNOLD WIGHAM BURTT. Water and Water Eng., 30: 360, 557, December 20, 1928. The Sandfields filtration plant of the South Staffordshire Waterworks Company, England, presents some interesting and unique points in design. In the first place the area on which the plant had to be placed was very restricted, being a narrow strip tapering from 94 feet wide at one end to 49 feet at the other. Again, the only main drain available for receiving the filter washings was the adjacent canal into which only clean water might be discharged. The plant consists of five distinct units including the administration block containing offices, laboratories, chemical stores, and preparation spaces; the filter house with 10 Paterson rapid sand filters; the precipitation tanks having a total capacity of 420,000

gallons; the wash water sedimentation tanks; and the filter-press house. The operation of the plant is of the usual nature, alumino-ferric being added to the raw water, followed by continuous flow sedimentation and after that chlorination. Dechlorination, if and when necessary, is also provided for. In the control of the alum dosage an electrically controlled tapered needle working in an orifice in the alum solution regulating chamber has proved successful. The water enters the precipitation tanks from a distributing trough extending the whole width of the tank through equidistant orifices designed to give uniform distribution at the plant rate of 4 mg. per day. At the rate of 2 m.g.d., it was found that uniform distribution was not obtained. To correct this, rings fitting the orifices and cutting down their diameter were found successful. The theoretical detention period in the precipitation tanks is 5 hours. Actual experiments have proven that of any volume of water entering the tanks at a given time, one-half will have passed through in three and one-half hours and four-fifths in five hours. The remaining one-fifth apparently takes a more devious path. The bottoms of the precipitation tanks are serrated and in the valleys are provided perforated tile pipes. Sludge is drawn off through these pipes and carried to the wash-water sedimentation tanks. Regular removal of sludge was found to be important, to avoid having a breeding ground for bacteria. The filters are cleaned by the use of air and water. A distinct pause between the closing of the air valves and the opening of the water valves was found to be beneficial in that ebullition is then not so violent that sand is washed into the waste channels by the incoming water. It was at first the practice to waste the filtered water for ten minutes after a filter was started following a cleaning. Observation, however, has proven this to be valueless. There is a definite dropping off in water quality after washing which is most noticeable at about 25 minutes after the filter has been started and continues for about 3 hours. This change in quality is so slight, however, as to be scarcely perceptible in the mixed water from all filters. The quality of the filtrate in the first ten minutes after washing has been found to be particularly good because it consists of purified wash water displaced from the sand by the incoming raw water. In studies with controlled amounts of alumino-ferric, it was found that percentage reduction in color and in oxygen absorbed, when plotted against alumina dose, give curves of the same general type; but the increase in purification with ascending alumina dosage is more marked in the color curve than in the oxygen absorbed curve. The writer also discusses the influence of alumino-ferric on the part played by the successive stages of purification. His principal conclusion is that at this filter plant the coagulant plays little part in the filtering action of the sand. However, this is not necessarily true if the coagulant had been added just before filtration and not some hours before. The writer's experience with this plant has led him to conclude that purification by the filters is not dependent on a surface film, but more probably on a gelatinous coating acquired by each sand grain and giving such grains the power of adsorbing bacteria and colloidal matter. In the Sandfields filter this coating appears to be mainly biological. Trouble has arisen with the appearance of a frothy scum in the pure water tank. This froth is formed as the water pours from the filters into the channels and from this channel into the pure water tank. In the summer

the development of algae in the clear water tank seems to be dependent on the froth. Due to the necessity of discharging only clean water, wash water sedimentation tanks had to be provided. Detention in these is from twelve to eighteen hours, after which the water is pumped back to join the incoming raw water and the sludge drawn off and passed through filter press. Experiments have indicated that the addition of alumino-ferric to the wash water sedimentation tanks would be helpful. The only water wasted at the plant is the sludge press effluent which comprises about 0.03 per cent of the total volume treated.—*Arthur P. Miller.*

Steel Storage Tank Improved the Water Service of Royal Oak, Michigan. R. J. WHITNEY. American City, 15: 1, 129, January, 1929. This brief article furnishes data pertaining to the construction of a 1.5 million gallon elevated storage tank to provide storage facilities for Royal Oak which is supplied with water from the distribution system of the city of Detroit through a 48-inch steel main over 2 miles in length. A booster pump is used to force water through this connection.—*Chas. R. Cox.*

The Water Supply of Fishers Island, N. Y. M. T. SINGLETON, American City, 15: 1, 143–4, January, 1929. Fishers Island, located in Long Island Sound near New London, Conn., is 7 miles long and ½ to 1½ miles wide. It consists of a deposit of sand, gravel, and boulders representing the morainic accumulations incidental to the glacier period. Many irregular sand hills surround the basins or depressions in which fresh water lakes exist. Four of such lakes are connected together and furnish the source of water supply. The water is colored incidentally to the decay of vegetation; otherwise it is not seriously polluted. Troubles from algae growths have been experienced in the past when the supply was not filtered, so that objectionable tastes were prevalent. A modern rapid sand filtration plant was constructed in 1927 to furnish an attractive water of safe sanitary quality to an exclusive real estate development on the Island. The filtration plant is under laboratory control in charge of a technically trained operator which is commendable considering the relatively small size of the plant. A very satisfactory effluent has been produced.—*Chas. R. Cox.*

The History of the Small Water Works Sinking Fund. CHAS. W. SHERMAN. American City, 15: 2, 85–86, February, 1929. The financing of small municipal water works systems is usually included in other municipal financing projects so that details are often obscure. The water commissioners of the town of Belmont, Mass., however, maintain separate accounts. The unusually complete records in this instance, therefore, are of special value as indicating the significant factors during the period 1896–1928. This tabulation, which cannot be abstracted satisfactorily, indicates that the interest earned by water works sinking funds of Belmont, Mass., had a mean value of 3.98 per cent, varying from 1.81 to 9.29 per cent.—*Chas. R. Cox.*

Electrolytic Chlorine for the Destruction of Algae. WM. T. BAILEY. American City, 15: 2, 103–5, February, 1929. The Council Bluffs, Iowa, water supply

is secured from the Missouri river and is coagulated and settled in very large sedimentation basins which provide a detention period of from four to seven days. The water is relatively clear in all but the first of these basins which are connected in series; thus ideal conditions exist for the prolific growth of algae. Previous to 1926 the algae growth was destroyed by a periodic dose of copper sulphate. This was found to be unsatisfactory; the water had a disagreeable taste and odor during the summer months. Dr. THORNELL of Council Bluffs conducted a series of tests in the use of liquid chlorine applied to the raw water and found that 0.8 to 1.0 p.p.m. chlorine almost completely stopped the growth of algae in the sedimentation basins and greatly inhibited their growth in the so-called clear water basins. The chlorine also caused all old growths to loosen from the walls of all the basins. Electrolytic cells were finally installed to produce chlorine, it being thought that this installation would be cheaper than purchasing chlorine gas. The current consumption of the cells was so regulated as to lead to the production of 0.5 p.p.m. chlorine, and this was gradually increased to 1.0 part. Within three or four days the growth on the walls of the basins began to loosen and float on the surface from which it was removed by skimming. Since the chlorine treatment was from 0.8 to 1.0 p.p.m., only a limited growth occurred. Difficulties were experienced in determining the exact amount of chlorine produced per unit of the current consumption of the cells. The asbestos diaphragms at the bottom of the cells have to be replaced at frequent intervals to prevent marked reduction in the efficiency of chlorine output per unit of current consumption. The dose of chlorine added to the water could not be ascertained by orthotolidine test due to the turbidity. At no time was residual chlorine present in any basin except that in which the freshly chlorinated water enters. A final chlorine dose was used to produce a residual chlorine content in the water entering the mains of between 0.06 and 0.2 parts per million. During such double chlorination of the supply very satisfactory bacterial removal has been secured, although when the prechlorine treatment was not practiced the same final chlorine dose was relatively ineffective. Some interesting data are given comparing the disinfecting properties of liquid chlorine with those of chlorine produced by the use of electrolytic cells. The data indicate that approximately the same degree of disinfection was secured with both methods.—*Chas R. Cox.*

Arctic and Western Hudson Bay Drainage. Water Resources Paper 50: 1927, Dominion Water Power and Reclamation Service, Department of Interior, Ottawa. Hydrometric investigations for the climatic year ended September 30, 1925.—*M. H. McCrady.*

Pacific Drainage, British Columbia and Yukon Territory. Water Resources Paper 51: 1927, Dominion Water Power and Reclamation Service, Department of Interior, Ottawa. Surface Water Supply data for the climatic year ending September 30, 1925.—*M. H. McCrady.*

Atlantic Drainage (South of St. Lawrence River), New Brunswick, Nova Scotia, Prince Edward Island. Water Resources Paper 52: 1927, Dominion Water Power and Reclamation Service, Department of Interior, Ottawa.

Hydrometric investigations for the two-year period ended September 30, 1926.—*M. H. McCrady.*

Annual Report 1925–26, Dominion Water Power and Reclamation Service. Dept. of Interior, Ottawa, Canada. The total installation to date in water wheels and turbines throughout the Dominion is 4,290,428 H.P., representing only 10¼ per cent of that possible with the recorded water power resources. 719,000 H.P. were added during the year.—*M. H. McCrady.*

Surface Films Protect Metals Against Corrosion. F. N. SPELLER. Chem. and Met. Eng., 36: 2, 85–7, February, 1929. The problem of corrosion has been known for a long time, but it is only recently that the controlling factors have received scientific study. The electrochemical theory of corrosion is now generally accepted. Surface films play an important part in the protection of iron, and where the corrosion products are insoluble the surface film formed may greatly retard the reaction. Ordinary corrosion is dependent upon the maintenance of a supply of free oxygen and water at the metal surface. Several factors such as temperature, rate of motion, hydrogen-ion concentration, local change in potential, protective films, and other variables influence the rate of corrosion. A protective surface film may be formed on iron when exposed to certain external film-building reagents such as chromic acid or oxygen, or the film may be formed by the presence in the metal of a sufficient amount of other elements such as chromium or silicon. A well-known example of film protection is found in the action of alkalies in solution. Steel with one-fourth of 1 per cent of copper has its life increased 2 to 4 times when exposed to the atmosphere, whereas the same steel exposed to water or under the soil is usually no better than steel without copper. The addition of 1 to 2 per cent of chromium, nickel, or silicon to iron has not given encouraging results, but when the chromium or silicon exceeds 12 to 14 per cent a very marked stability is produced.—*John R. Baylis.*

Natural Formation of Protective Coatings in Iron Pipes by Cold Water. I. Adsorption of CO_2 By Ferric Hydroxide. (Die Selbsttätige Schutzschichtbildung durch kaltes Wasserleitungswasser in eisernen Röhren. I. Die Adsorption von Kohlensäure durch Ferrihydroxyd.) J. TILLMANS, P. HIRSCH and K. SCHILLING. Gas- und Wasserfach, 3: 49; 4: 78; January 19 and 26, 1929. The theory is formulated and established by suitable tests that dissolved carbon dioxide is adsorbed by ferric hydroxide. An explanation is offered of the dependence of such adsorption upon the contents of free and bound carbon dioxide. Adsorption of CO_2 from water containing calcium bicarbonate may affect the "calcium-carbon-dioxide" equilibrium and may consequently lead to the precipitation of calcium-carbonate. This action is believed to be the cause of the formation of calcium rust protective coatings. —*Richard F. Wagner.*

City Held Liable in Damages for Sewage Pollution of Stream. (Indiana Appellate Court; City of Frankfort *vs.* SLIPHER, 162 N. E. 241; decided June 19, 1928.) Public Health Reports, 43: 35, 2285, August 31, 1928. The city

unlawfully emptied its sewage into a natural watercourse flowing through appellee's farm. It was held, among other things, that this condition was dangerous to public health and that by expenditure of a reasonable sum the city could have adopted a method of purifying the sewage. **City Held Liable for Sewage Pollution of Stream.** (Oklahoma Supreme Court; City of Enid *vs.* BROOKS, 269 P. 241; decided July 24, 1928.) Public Health Reports, **43**: 38, 2476, September 21, 1928. City sewage emptied into a stream a mile above the property of the plaintiff, causing the latter to abandon the dairy business for which the property was especially suited. **City Held Liable for Sewage Pollution of Spring and Lake.** (Missouri Supreme Court, Division 2; WINDLE et ux. v. City of Springfield, 8 S. W. (2d) 61; decided June 21, 1928.) Public Health Reports, **43**: 38, 2476, September 21, 1928. Seepage from the city sewer on city property, polluted a spring and lake of plaintiff, rendering them unfit for use. **Recoveries against City because of Typhoid Fever and Dysentery Caused by Impure Water.** (California Supreme Court; RITTERBUSCH et al. *vs.* City of Pittsburg; and 18 other cases, 269 P. 930; decided August 30, 1928.) Public Health Reports, **43**: 42, 2774, October 19, 1928. Successful action to recover damages was brought against the City of Pittsburg, for death by typhoid. The disease was shown to have been caused by inoperation of the chlorination plant for twelve hours about three weeks preceding an epidemic of typhoid fever and dysentery.—*R. E. Noble.*

ABSTRACTS, SUBCOMMITTEE NO. 9

JOINT RESEARCH COMMITTEE ON BOILER FEEDWATER STUDIES

Age Hardening of Boiler Plate and its Prevention (Alterungserscheinungen an Dampfkesseln und ihre Vermeidung). F. NEHL. Zeit. des Bayerischen Revisions-Vereins (Munich), **32**: 23 and 24, December 15 and 31, 1928, pp. 315–317, 6 figs. and 324–325, 1 fig. Causes and effect of aging are discussed and two means of prevention are recommended; first is use of steel less subject to aging; cost of such material, however, is often prohibitive; by use of welded drums of standard steel, it is possible to obtain boiler material entirely resistant to aging.

Modern Conception of Formation and Prevention of Boiler Scale (Conceptions modernes sur la formation et la prévention des incrustations de chaudières). R. STUMPER. Société Chimique de Belgique—Bul. (Paris), **7**: 10, October, 1928, pp. 105–122, 5 figs. Discussion of chemistry of steam boilers; theory and dynamics of scale formation.

Corrosion and Protection of Metals Used in Steam Boilers (Korrosion und Metallschutz im Dampfkesselbetrieb). R. STUMPER. Korrosion und Metallschutz (Berlin), **4**: 10, October, 1928, pp. 217–227, 9 figs. General discussion of recent chemical theories and observations. International bibliography of about 30 references.

Watch the Outside Surface of Your Boiler. I. S. CHAMBERLAIN. Power, **68**: 25, December 15, 1928, pp. 998–999. Subject of external corrosion of boilers

in general seems to be one that has not received its due share of attention; as damage and expense from this source can readily be prevented in many instances, matter should be taken up wherever it is needed.

Some Experiments of the Circulation of Water in a Vessel Associated with Ebullition Shown by Cinema Film. K. TAKEMURA, Y. HOSOKAWA, I. MASAKI and K. SUGIYAMA. Soc. Mech. Engrs.-Jl. (Tokyo), **31**: 136, August, 1928, pp. 520–529, 13 figs. Present experiment aims to reveal hidden mystery of circulation in vessel of complicated form, all parts being made of glass; experimental vessels, arrangements, and results (English).

Evaporators. Colliery Eng. (Lond.), **5**: 57, November, 1928, pp. 445–447 and 453, 2 figs. Consideration of urgent need of pure feedwater due to severe operating conditions imposed by modern practice; principles of operation of evaporator; features of design; different types of evaporators.

Vacuum Degasification in Boiler Plants (Die Vakuumentgasung im Waermekraftbetrieb). M. ROHRLACH. Archiv fuer Waermewirtschaft (Berlin), **9**: 11, November, 1928, pp. 361–364, 5 figs. Necessity of oxygen removal from feedwater is pointed out; advantages of degasification; arrangement of degasifying installation in boiler plant and its thermotechnical advantages; cost of installation.

Distilled Make-Up Feed Water. D. G. MCNAIR. Mech. World (Manchester), **84**: 2191, December 28, 1928, pp. 603–606, 3 figs. Consideration of evaporator and important part which it plays in maintaining continuously reliable and efficient performance in high-pressure steam plant; multiple-effect evaporation and different types of evaporation; description of Holden and Brooke surface evaporator with details of operation and cleaning; Vickers-Armstrong flashing evaporator.

Boiler Feedwater Regulation. Power Plant Eng., **33**: 2, January 15, 1929, pp. 118–120, 5 figs. Review of recent innovations in equipment offered by following concerns: Northern Equipment Company, Reliance Gauge Column Company, Stets Company, and Swartwout Company.

Neckar Water Purification System and its Use for High-Pressure Boilers (Das Wasserreinigungssystem Neckar und dessen Verwendungsmoeglichkeit fuer den Hochdruckkessel). E. HAAS. Waerme (Berlin), **51**: 51, December 22, 1928, pp. 932–935, 8 figs. Neckar process is described together with developments in past ten years; system was introduced in 1908 and is improvement of regenerative system developed in 1888; its use for high-pressure boilers.

Feedwater Treatment and Heating. Power Plant Eng., **32**: 24, December 15, 1928, pp. 1309–1311, 2 figs. Combination methods, especially of evaporation with other types, characterize present treatment tendencies; developments in extension and perfection; evaporators used to reduce concentration;

more discharge by continuous blowdown; continuous sludge removal reduces hardness; equipment arrangement determines method; stage heating and heat recovery increasing; corrosion and embrittlement prevention.

Tendencies in the Conditioning of Boiler Feed Water. R. E. HALL. Power House, (Toronto), **22**: 23, December 20, 1928, pp. 18–19 and 39–40. Paper provides accurate and comprehensive review of present conditions, indicating that prevention of scale, corrosion, and embrittlement and production of dry steam demand definite relations which must be maintained throughout cycle. Paper presented before American Social Mechanical Engineers, previously indexed from Power Plant England, November 1, 1928.

Boiler Water Treatment. Power Plant Eng., **33**: 2, January 15, 1929, pp. 121–122, 3 figs. Review of recent innovations in equipment offered by following concerns: Leeds and Northrup Company, Permutit Company, Reisert Automatic Water Purifying Company, Reiter Company and W. B. Scaife and Sons Company.

Cost of Impurities in Locomotive Water. Am. Ry. Eng. Assn.-Bul., **30**: 310, October, 1928, pp. 139–142, 2 figs. Review progress in water treatment on railroads and reports on possible future development.

New Water Treater Fits on Locomotives. Boiler Maker, **28**: 12, December, 1928, p. 361, 3 figs. Apparatus for chemically treating boiler feedwater, that is attached directly to locomotive, has been developed and put in use on Chicago & North Western; no attention required during run; kind and quantity of chemical depends in all cases upon character of water supplied to locomotives.

The Chemical Control of Boiler Plant. C. N. RIDLEY. Indus. Mgmt. (Lond.), **15**: 12, December, 1928, pp. 432–433 and 435. Chemist is essential factor in economy of steam-raising; chemical analysis of boiler water, determining concentration of water in boiler, routine and alkalinity tests are dealt with; blowing down of boilers. (Continuation of serial.)

Methods of Providing Drinking Water at Coach Yards, Including Study of Hydrants, Nozzles, Connections, Etc. Am. Ry. Eng. Assn.-Bul., **30**: 310, October, 1928, pp. 202–206, 3 figs. Discussion covering use of hose, hydrants, nozzles, and connections in watering passenger coaches; attention is directed to details in handling which present least opportunity for contamination of drinking water.

Report on the Use of Gravity and Pressure Filters. Am. Ry. Eng. Assn.-Bul., **30**: 310, October, 1928, pp. 158–170, 3 figs. Considerable data on use of filters in railway service; filter examples; adaptability to railway service; requirements of efficient filters; sand beds; washing; typical costs of filters are shown in table; gravity vs. pressure filters; rapid vs. slow filters.

Power Economies from New Equipment. C. G. KLOPP. Mfg. Industries, 17: 1, January, 1929, pp. 31–36, 12 figs. Equipment of Champion Fibre Co. is described; high pressure boiler; turbo-generator and auxiliaries installed by manufacturing plant; need for more electrical power, with practically no increase in total steam production; course of steam from turbine; installation of boiler; furnace construction; draft fans; coal-handling equipment; water-treating system.

Composition and Use of Ferric Hydroxide Coagulant. E. S. HOPKINS. Indus. and Eng. Chem., 21: 1, January, 1929, pp. 58–60, 4 figs. Practical operating data governing use of ferric hydroxide floc as coagulant and maximum removal of turbidity by it, as well as discussion of its theoretical composition; iron removal.

Aftergrowths in Water System. J. R. BAYLIS. Can. Engr. (Toronto), 55: 25, December 18, 1928, p. 760. Author discusses bacterial aftergrowths in water mains; comparison of chlorinated filtered water and water after passing through distribution system; there is no need of being alarmed at bacterial aftergrowth where it is known that pollution cannot gain entrance to supply. Paper presented before American Society for Municipal Improvements.

Methods of Water Softening. I. LAVINE. N. Dakota Engr., 4: 3, March, 1928, pp. 2–5, 15 and 18, 1 fig. Sources of impurities in water; hardness of waters; effects of impurities; boiler compounds; chemical treatment; zeolites or base-exchange silicates; operation of zeolitic softners; advantages that zeolite method offers.

Water Purification Progress During the Year 1928. N. J. HOWARD. Contract Rec. (Toronto), 42: 52, December 26, 1928, pp. 1355–1361, 1 fig. Chief activities in water treatment field have centered on coagulation problems, including mechanical agitation and cleaning devices, on more extended use of chlorine and on water softening and recarbonization; no radical changes in plant design.

Liquid Sodium Aluminate in Clarification L. J. RIPPLE, G. J. TURRE and G. H. CHRISTMAN. Water Works Eng., 81: 26, December 19, 1928, pp. 1795–1796, 1822 and 1825–1826, 5 figs. Use of this chemical in conjunction with alum in coagulation of Denver water supply; some advantages claimed; Marston Lake North Side filters; sodium aluminate-alum treatment; development of floc; operation of filters; comparison of two systems; reduction of alum dosage. Paper presented before American Chemical Society.

Plants for Treatment of Black Waters at Fort Worth, Texas (Plantas de tratamiento de aguas negras de fort Worth, Texas). M. JINICH. Ingenieria (Mexico, D.F.), 2: 11, November, 1928, pp. 499–504, 7 figs. Legislation in 1913 prohibited stream pollution, forcing Fort Worth to remodel sanitation plant; description of new plant, with Imhoff tanks, sprinkling filters, and Dorr clarifiers; designed for 7,500,000 gallons per day.

Boiler Compound. Aktieselskapet Norsk Kjelerensningsmiddel. Norw. 42, 895, June 27, 1927. Chem. Abstracts **22**: 21, November 10, 1928, page 4193. The following composition is added to the water: 25 to 35 parts of caustic soda, 7 to 10 Na_2CO_3, 0.8 to 1.2 quebracho, and 80 to 130 H_2O.

Boiler-Corrosion Problems. SPELLER, F. N. Fuels and Steam Power, Am. Soc. Mech. Eng. Trans. **50**: 222–3 (1928). Chem. Abstracts, **22**: 21, November 10, 1928, page 4191. Problems for investigation are: corrosion rate and H_2 evolution in the absence of dissolved O_2 through range of acidity and alkalinity in general practice and 140 to 450°F; the same with dissolved O_2 present within practical ranges; determination of dissolved O_2 in operating boilers at different points in the boiler; determination of H-ion concentration, alkalinity or acidity at boiler temperatures vs. 68°F., and effect of dissolved salts on the same; formation of protective films on heating surfaces and relation to dissolved O_2, alkalinity, acidity, chlorides; pitting under scale; electrolytic prevention; corrosion from organic materials; action of inhibitors at boiler temperatures.—*E. M. Symmes.*

Boiler-Feed Water. MCALLEP, W. R. Facts about Sugar, **23**: 950–1 (1928). Chem. Abstracts **22**: 22, November 20, 1928, 4686. To replace steam losses under the conditions obtaining in Hawaiian Sugar mills some 130 to 260 pounds of make-up water are required per ton of cane. Fresh water is generally used for this purpose. M. recommends the use of condensed vapors (as in beet sugar plants), of which there is an excess of about 400 pounds per ton of cane after the requirements of maceration and filters are satisfied. For maintaining the required pH in the boiler water he suggests the use of lime water in preference to Na_2CO_3. NaOH, derived from the latter by hydrolysis under modern boiler pressures, may accumulate to such a concentration around rivets and in other capillary spaces as to involve embrittlement hazards.—*M. J. Proffitt.*

Condenser Leakage; its Detection and Effect on Boiler-Water Concentration. CARMICHAEL, W. C. Power **68**: 267–70 (1928). Chem. Abstracts, **22**: 21, November 10, 1928, page 4192. Directions are given for determination of alkali and chloride.—*D. B. Dill.*

The Countercurrent Electric Process. SCHULZ, E. Arch. Wärmewirt. **6**: 247–8 (1925). Chem. Abstracts **22**: 22, November 20, 1928, page 4687. The front and back of the boiler are connected to the 2 sides of a d.c. line through 2 C-filament lamps. This prevents the formation of boiler scale and loosens old scale. The mechanism is doubtful; presumably it is an electrolytic effect. —*Ernest W. Thiele.*

Experience With a Boiler-Scale Preventive. BROGLIO, N. Arch. Wärmewirt. **9**: 111–5 (1928). Chem. Abstracts **22**: 22, November 20, 1928, page 4687. Broglio describes the good results obtained with a proprietary product, "Tartricid," stated to consist mainly of substances similar to tannic acid.—*E. W. T.*

Fractured Boiler Plates. NESS, GEORGE and MACCALLUM, DOUGLAS A. J. West. Scot. Iron and Steel Inst. 35: 101–9 (1928). Chem. Abstracts 22: 21, November 10, 1928, page 4191. Several cases are given of fractured boiler plates and straps, along with analysis of scales occurring between straps and plates. Analysis of feed water and boiler water after forty-three days steaming are given. It is concluded that the origin of fractures can be traced to purely mechanical causes, and that caustic embrittlement is not a necessary cause of failure. Numerous photomicrographs of steels are given.—*J. K. Roberts.*

Minerals Affect Feed Water. ROMER, J. B. Power Plant Engineering, 32: 923 (1928). Chem. Abstracts, 22: 22, November 20, 1928, page 4687. Impurities in boiler feed water result in scale, corrosion, embrittlement, priming and foaming with consequent weakening, early failure, and wet steam. Boiling water at atmospheric pressure removes Ca, Mg and carbonate. These, in precipitated form, should be allowed to settle out before the water enters the boiler. The decreasing solubility of $CaSO_4$ with rise in temperature causes it to precipitate on the hottest parts, making an insulator and causing blister, and eventually ruptures in boiler tubes. Non-scale-forming salts, such as $MgSO_4$, $CaCl_2$, $MgCl_2$ after they have been hydrolyzed may cause corrosion. Ideal feed water is hard to obtain and treatment inside the boiler is never as good as outside treatment.—*S. D. Poarch.*

Modern Practice in Boiler Feed-Water Purification. FOXWELL, G. E. Gas World, 89: September Coking Sect. 10–4 (1928) Chemical Abstracts, 22: 21, November 10, 1928, page 4190. A review and discussion of causes and methods of prevention of scale and corrosion.—*F. S. Granger.*

Preventing Corrosion and Incrustation in Boilers. Soc. Des Perfectionnements Appliqués à L'Industrie. Brit. 285,057, February 10, 1927. Chem. Absts., 22: 22, November 20, 1928, page 4695. An emulsion is formed from vegetable seed cake such as linseed cake, for use in preventing incrustation or corrosion.

Preventing Incrustation in Boilers. BREYER, H. Brit. 284–629, February, 1927, Chem. Abstracts, 22: 22, November 20, 1928, page 4695. Acid wastes such as those from mines or steel mills are passed through porous $CaCO_3$ and maintained in contact with the $CaCO_3$ for two to five minutes in order to avoid deposition of $Fe(OH)_3$ on the $CaCO_3$. U. S. 1,685,301 specifies the use of travertine or a $CaCO_3$ material of similar porosity. Cf. C. A. 22: 2632.

Preventing Incrustation in Boilers. LAZARUS. W. Brit. 283,517, January 12, 1927. Chem. Abstracts, 22: 21, November 10, 1928, page 4193. The use of soot and soda as described in Brit. 271,337 (C. A. 22: 1642) is modified by the use of a larger quantity of soot, charcoal or plumbago in finely divided form, and of an alkali or alkaline carbonate adapted to the total hardness of the water. Alkali or alkaline carbonate is subsequently added daily.

Prevention of Corrosion in the Chemical Cleaning of Condensers and Boilers. LIENEWEG, FR. Wärme, **50**: 507–11; Chem. Zentr., 1927, II, 1301. Chem. Abstracts, **22**: 22, November 20, 1928, page 4687. The influence of boiler scale on the economy of condensers and boilers is discussed, and the necessity of a thorough and frequent removal of the scale emphasized. The corrosion sometimes occurring in the cleaning (with HCl, etc.) is limited by adding preservatives. The various kinds of corrosions are described and advice is given for their prevention.—*G. Schwoch.*

Treatment of Boiler Feed Waters of Low Incrustant Content. JOHNSON, S. C. Ind. Eng. Chem., **20**: 1071–2 (1928). Chem. Abstracts, **22**: 22, November 20 1928, page 4686. Few water supplies are so good that some form of treatment does not improve them. The controlled addition of predetermined amounts of suitable softening agents and a satisfactory blowoff schedule amply reward the efforts and expenditures involved in the treatment of waters of even low incrusting solid content.—*J. A. Kennedy.*

Treatment of Missouri River Water for Locomotive Use. RICHARDSON, H. H. Ind. Eng. Chem., **20**: 924–5 (1928). Chemical Abstracts, **22**: 21, 4190, November 10, 1928. Lime-soda ash water-softening plants have been installed at 10 points where Missouri River water is used. Untreated city water is being used at 3 other points. Na aluminate is used in all but 2 of the plants where the water is being treated. Statistics and further details of operation are given.—*J. A. Kennedy.*

Use of Iron Silicate as a Filtering Medium for Hot Alkaline Boiler Waters. HALL, RALPH E. (to JOHN M. HOPWOOD). U. S. 1,686,558, October 9, Chem. Abstracts, **22**: 22, November 20, 1928, page 4695. An apparatus is described.

NEW BOOKS

Proceedings of the Second Annual Conference, Maryland Water and Sewerage Association, Baltimore, Md., April 10 and 11, 1928. 102 pp. **Private or Public Ownership of Water Systems.** ROBERT B. MORSE. 3–9. As a fair and equitable allocation of costs of water service the author proposes: (1) a small tax on the entire district to cover general intangible benefits, (2) a frontage or area assessment upon property on streets where there is a main to cover the tangible benefits, (3) service charges and rates to cover direct maintenance and operation costs. The above scheme is of course applicable only to government ownership. Private financing and ownership eliminate difficulties due to political status while extensions to new areas are more easily financed under government ownership. As obstacles to the construction and extension of water works the author cites public apathy or opposition due to fear of increased taxation, the inability to finance due to political status and unfavorable policies with respect to extensions into newly subdivided areas. Obstructions to operation are low salaries, short tenure of service, incompetency, and the effect of politics. In general, operation under private ownership is more efficient and economical. The author cites certain regional aspects of

the situation, pointing out that large water districts offer the opportunity for concentration of effort in purchasing and management, avoid duplication of structures and conflicts of interests in water rights. The private company is even better able to utilize these advantages since it is bounded by no political limits. The author concludes that neither type of ownership is best in all cases. **The Advantages of Public Utility Ownership by Parent Corporations.** V. BERNARD SIEMS, 10–14. The present trend is away from public operation of all sorts of public utilities, including water works. The Water Utility Parent Corporation, by reason of the large-scale production facilitates financing, enjoys state control, and profits from management by experts. Centralized control benefits the individual. Important works have come through the agencies of sound engineering, proper financing, capable management, centralized purchasing power, better banking facilities, and the release of the local management from financial problems. The author claims that the tax burden on public utilities is greater than that imposed upon manufacturing, trade, and banking institutions and that the taxes on utilities should be lower. He argues further for a uniform regulation of rates, valuation, and service by public service commissions in all states. *Discussion.* H. CARL WOLF. W. agrees in general with the author's propositions, but concurs with MORSE that neither public nor private ownership has proven the proper answer in all cases. **Fire Insurance Rates in Relation to Water Supply Improvements.** F. H. DRYDEN. 17–23. D. cites the building of a new water works system at Salisbury, Md., as a result of which the deficiency charge on fire insurance rates was reduced 18 cents per $100. *Discussion.* W. C. MUNROE cites experience at Annapolis to show importance of distribution main capacity. A. E. WALDEN cites several instances of reduction in rates due to improvements in general fire defenses. R. B. MORSE indicates impracticability of spacing hydrants as close as 200 or 250 feet in order to avoid Underwriter's penalty. B. E. BEAVAN and A. WOLMAN point out the necessity of improving the fire defenses more important than water supply in order to reduce rates. **Does the Municipality Know What it Costs?** THOMAS S. DURHAM. 24–29. The marked benefits to successful and economical management of a water works system of an adequate system of cost accounting are pointed out. *Discussion*, by F. W. CASPARI, R. B. MORSE, A. E. WALDEN, F. H. DRYDEN and A. WOLMAN relates principally to financing problems on the Washington Suburban Sanitary District. **The Value of Residual Chlorine Tests for Chlorination Control.** J. G. PATRICK. 36–38. The residual chlorine test by the *ortho*-tolidin method is found valuable in insuring adequate dosage of chlorine without the application of excessive amounts. Over-dosage is to be avoided in order to eliminate the waste of chlorine and to prevent the development of the unpleasant tastes and odors that result from excess dosage. The author cites instances of popular theories concerning various effects of chlorine, such as its effects upon the digestive organs of the body, unpleasant tastes produced when water containing it is used in preparation of tea and coffee, its effects upon fish, bird, and plant life, and its corrosive effects upon metal pipes and fixtures. Most of these theories are erroneous. **Comments on Methods for Determination of Residual Chlorine.** LINN H. ENSLOW. 39–49. The author gives a very comprehensive discussion of four well-known methods of determining

residual chlorine. (1) *The Starch Iodide Ttitration* method is said to be very accurate when employed in the absence of interfering substances, but misleading results are given when used with waters bearing ferric iron compounds, manganic compounds and nitrites. (2) *The Starch Iodide Colorimetric* determination is subject to the same objections as the starch iodide titration method and in addition is less delicate due to the variation in shades of blue used as an index. Re-agents for this method are difficult to maintain in good condition. (3) *The Benzidine Hydro-Chloride* method, employed to some extent in Europe, has advantages of definite colors and sensitiveness. This method is affected by manganic compounds but not by iron. (4) *The Ortho-Tolidin* method is discussed in great detail. The effects of manganese, iron, nitrites and nitrates, pH value, temperature, and time of reaction upon the results are given. Methods of compensating for color, turbidity, manganese, and other interfering substances are suggested. **The Problems in Industrial Uses of Water in Stationary Steam Practice.** WILLIAM KRUMBINE, 50 and 51. The author cites the various difficulties that arise in the use of waters for boiler purposes and points out the value of water treatment directed by competent chemical control. **Treatment of Water for Railroad Purposes.** R. C. BARDWELL. 52–57. Water supply is the most important commodity used by railroads. The total annual water consumption by American railroads will average 500 billion gallons, of which amount 350 billion are for steam purposes. The investment in water supply facilities amounts to $300,000,000 and entails an annual expense of $50,000,000 for operation and maintenance. About 70 million gallons (20 per cent) are treated, from which are removed about 140 million pounds of scale-forming matter. It is estimated that about 80 per cent of the water used for steam purposes could be improved by treatmnnt. Surface water is to be preferred to ground water. The principal methods of treatment used are the introduction of boiler compound or chemicals, such as soda ash, direct into engine tanks and boilers, the operation of lime and soda ash treatment plants at road-side points and the use of base-exchanging softeners. On the basis of figures developed by the American Railway Engineering Association of 1914, the present cost and expense of each pound of incrusting matter permitted to enter boilers is estimated at 13 cents, a figure believed to be decidedly small. Savings resulting from water treatment range from $500 to $4,000 per locomotive per year. **Treatment of Laundry Wastes.** L. E. SAKERS and F. M. ZIMMERMAN, 70–73. The Franklin Wet-Wash Laundry uses about 300 pounds of soda, 200 pounds of soap chips and 130 pounds of chlorine solution in handling about 8700 pounds of wet-wash. The waste from the laundry, consisting of soapy water, dyes, grease, and dirt are discharged into a small stream. As a result of a court order the Laundry, following experiments and investigations, installed a waste treatment plant involving chemical equipment for feeding iron and lime, a mixing tank, a settling tank, and cinder filter. The chemicals used are approximately 10 pounds of lime and 2½ pounds of iron per thousand gallons of waste, and the cost is about 12¼ cents per thousand gallons treated. The sludge from the tanks is run on to a filter about 9 by 15 feet in area filled with 1-foot graded cinders and underdrained by ordinary farm tile. The sludge amounts to about 60 cubic feet per week and under normal summer conditions dries in two days. The following are results obtained:

	RAW WATER AT TUBS	SETTLING TANK EEFLUENT	CINDER FILTER EFFLUENT	PER CENT REMOVED
Turbidity	700	225	50	92.9
Color	225	140	80	64.6
Total solids	3,175	1,690	1,065	66.5
Suspended solids	1,150	357	38	96.7
Oxygen consumed	828	179	89	89.3

Swimming Pool Sanitation in Baltimore. M. B. COBLENTZ. **Baltimore City Health Department.** 74–87. Pools in Baltimore are scored. The average rating of indoor pools has risen from 67 to 90 per cent. Bather control is the most difficult procedure in pool operation. Ultra-violet ray treatment has been found unable to maintain satisfactory bacterial quality in the water. Chlorine treatment has generally maintained satisfactory qualities. Detailed figures supporting these conclusions are given. The system and the forms used in rating swimming pools are included. The discussions following the paper bring out many pertinent points in the sanitary control of swimming pools. **Cross Connections and their Elimination.** EUGENE J. CANTON. 88–90. Some 2,232 investigations of supplies in Baltimore have been made, among which sixty-seven cross-connections were found and owners notified. Subsequent inspections showed that forty-three of these had been corrected. The author cites the possible ways in which cross-connections are serious sanitary menaces. **Water-Waste or Leakage Survey.** ALBERT HEARD, 91–92. The author cites the results of a careful leakage survey made in Hagerstown, Md., by the pitometer method. Several valves intended to be opened were found to be closed. All meters of 2-inch size were tested. Sixty-six leaks of various kinds and sizes were found and repaired. They ranged in quantity from a service leak of 2,000 gallons per day to broken mains leaking as much as 150,000 gallons per day. A total leakage of nearly 600,000 gallons per day was found. With water costing 10 cents per thousand gallons this meant approximately $60.00 per day. The cost of the survey was $3,500 which was returned by the saving in leakage in less than three months. **Obtaining Good Results from a Filter.** A. L. GOSNELL. 93. The author points out small but important maintenance jobs that yield returns in the operation of a filter plant. **Inspection and Maintenance of Filter Beds.** J. M. JESTER. 94. and 95. Frequent and critical inspections should be made of filter beds, noting particularly the sand loss, mud balls, cracks or craters on the sand surface, distribution of under-drainage gravel through the sand, distribution of wash water through the filter sand, and rate of application of washwater.—*R. L. McNamee.*

Transactions of the Eighth Annual Conference of State Sanitary Engineers, 1927. Public Health Bulletin **182,** 133 pages, October, 1928. Those sections of Water Works interest follow: *Water Purification and Treatment.* The committee's major activity has been concerned with a study of the limitations of

chlorination as practiced in connection with water filtration. Certain bacterial relationships in the steps of purification have been established for chlorinated and unchlorinated effluents, for well designed and operated modern rapid sand filtration plants treating river waters. Plans have been provided for collecting detailed year-period laboratory records from 75 or 80 representative purification plants in about 40 states. These data are expected to amplify and perhaps modify the relationships described. Suggestion was made to initiate a five-year census of filtration plants; also to correlate activities of the committee with parallel committees of other associations. *Sanitary conservation of Streams.* The problem is to provide and enforce statutes which will prevent undue and harmful pollution of water resources and provide for reasonable and proper use of streams. Conservation means preferably the determination of the pollution load which each stream or part thereof can inoffensively and harmlessly assimilate, if any; then the use of the stream to that extent and requirement for treatment of all excess pollution. Isolated instances of exception exist. In order of importance water resource uses are: (1) As public water supplies, (2) For conveyance and dilution of treated or untreated sewage and industrial wastes within the capacity of the receiving water, (3) Navigation, manufacturing, industry, power, irrigation, agriculture, fishing, and recreation. Ideal statutes, administration, and coöperation are discussed. *Pump Specifications.* Proper sanitary survey and mechanical conditions to be maintained for pumps are detailed under location and general considerations. Materials and construction for dug and bored wells, double tubular drilled wells, driven and singular drilled wells, and the design of hand pumps are elaborated upon. *Camp and Outdoor Sanitation.* Special reference to posting of signs designating safety of water supplies was made. Discussion was made of these miscellaneous subjects: *Sanitary Defects Permitting Contamination of Ground-Water Supplies; Code of Principles on Sanitary Control in the Development of Ground-Water Supplies; Use of Sodium Aluminate in Filter Plant Operation; Standardization of Chlorine Tank Valves; Chlorination of Well Water; Use of Oil Lubrication for Submerged Bearings; Recreational Use of Water-Supply Reservoirs; Retardation of Chlorine Reaction in Water.*—*R. E. Noble.*